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EVALUATION OF GUIDE RAIL IN CONJUNCTION WITH KAISER AND HARVEY LANDING MAT (AM2)

by

C. D. Burns

W. R. Barker

October 1966

Sponsored by

Naval Air Engineering Center
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ASSOCIATED REPORTS

Report No.	Title	Date
MP 4-501	Development of CBR Design Curve for M9M2 Landing Mat	June 1962
MP 4-581	Evaluation of M9M1 Landing Mat	July 1963
MP 4-599	Development of CBR Design Curves for AM1 Landing Mat	Sept 1963
MP 4-615	Development of CBR Design Curves for Harvey Aluminum Landing Mat (AM2)	Jan 1964
MP 4-656	Evaluation of Convair Landing Mat	June 1964
MP 4-655	Development of CBR Design Curve for Modified AM1 Landing Mat	June 1964
MP 4-747	Evaluation of Harvey Modified AM2 Landing Mat	Oct 1965
MP 4-753	Evaluation of Washington Aluminum Company AM2 Landing Mat	Jan 1966
MP 4-786	Evaluation of Various Sizes of Harvey Aluminum AM2 Landing Mat	Jan 1966
MP 4-787	Evaluation of Various Sizes of Butler AM1 Landing Mat	Jan 1966
MP 4-788	Evaluation of AM2 Landing Mat Replacement Panels and Keylock Assemblies	Jan 1966
MP 4-789	Evaluation of Butler AM2 Landing Mat	Feb 1966

FOREWORD

The investigation reported herein is the thirteenth in a series of landing mat tests performed by the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., for the Naval Air Engineering Center (NAEC), Philadelphia, Pa. The previous reports in this series are listed on the inside of the front cover of this report.

The investigation was authorized by NAEC in Project Order No. 6-4006, dated 6 August 1965, and was conducted by WES during September and October 1965.

Engineers of the WES Soils Division who were actively engaged in the planning, testing, analyzing, and reporting phases of this investigation were Messrs. R. G. Ahlvin, W. L. McInnis, C. D. Burns, W. R. Barker, and M. J. Mathews under the general supervision of Messrs. W. J. Turnbull and A. A. Maxwell, Chief and Assistant Chief, respectively, of the Soils Division. This report was prepared by Messrs. Burns and Barker.

Colonel John R. Oswalt, Jr., CE, was Director of the WES during the conduct of this investigation and the preparation of this report. Mr. J. B. Tiffany was Technical Director.

CONTENTS

	Page
FOREWORD	iii
SUMMARY	vii
PART I: INTRODUCTION	1
Background	1
Objectives and Scope of Investigation	2
Definition of Traffic Terms	3
PART II: GUIDE RAIL, MAT, TEST SECTION, AND TEST LOAD CART	5
Guide Rail	5
Mat	5
Test Section	7
Guide Rail and Mat Placement	8
Test Load Cart	10
PART III: TESTS AND RESULTS	11
Traffic Tests	11
Soil Tests and Miscellaneous Observations	12
Behavior of Guide Rail and Mat Under Traffic	12
Summary and Analysis of Test Results	22
PART IV: CONCLUSIONS	25
TABLES 1-3	
PHOTOGRAPHS 1-24	
PLATES 1-15	

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SUMMARY

This investigation was conducted to evaluate the performance, under simulated aircraft loadings, of (a) a guide rail (for use in assisted take-offs) designed for use with Airfield Matting No. 2 (AM2), (b) Kaiser Aluminum Company's AM2 when used in conjunction with guide rail and when used without guide rail, and (c) modified AM2 from Harvey Aluminum, Inc., when used in conjunction with guide rail. It was specifically desired to determine the effect that subgrade strength and soil type would have on the performance of the guide rail and AM2.

Accelerated traffic tests were performed on a specially prepared test section consisting of one item of loose sand and three items of heavy clay soil constructed to various CBR values and surfaced with Kaiser AM2 in conjunction with a guide rail and without a guide rail. Comparative traffic tests were also performed on Harvey modified AM2 placed in conjunction with a guide rail. Traffic was applied with a special test load cart equipped with a single-wheel main-gear assembly load of 27,000 lb and a 30-7.7 tire inflated to 400 psi.

Based on the results obtained in this investigation, it is concluded that:

a. The guide rail used in conjunction with AM2 in this study will sustain aircraft operations without structural damage under the conditions of subgrade strength, wheel load, and load repetitions indicated in subparagraphs b, c, and d below. However, some anchoring may be necessary to maintain true longitudinal alignment of the guide rail.

b. The Kaiser AM2 used in conjunction with the guide rail on a subgrade having a CBR of 10 will sustain approximately 90 passes of a 27,000-lb single-wheel load and 400-psi tire inflation pressure when applied in a single path at the junction of the guide rail and the mat.

c. Harvey modified AM2 used in conjunction with the guide rail on a subgrade having a CBR of 10 will sustain about 470 passes of a 27,000-lb single-wheel load and 400-psi tire inflation pressure when applied in a single path at the junction of the guide rail and the mat.

d. The Kaiser AM2 used in conjunction with the guide rail on a subgrade having a CBR of 5 or more will sustain 1600 passes of a

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27,000-lb single-wheel load and 400-psi tire inflation pressure when applied in a single path approximately 7.5 ft away from the guide rail.

e. The Kaiser AM2 used without the guide rail on a subgrade having a CBR of 15 or more will sustain 1600 cycles (188 coverages) of a 27,000-lb single-wheel load and 400-psi tire inflation pressure.

EVALUATION OF GUIDE RAIL IN CONJUNCTION WITH KAISER AND HARVEY LANDING MAT (AM2)

PART I: INTRODUCTION

Background

1. For several years the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., has been engaged in a study for the Naval Air Engineering Center (NAEC), Philadelphia, Pa., for the purpose of evaluating various types of landing mats for use in surfacing small airfields for tactical support (SATS) in amphibious operations. A SATS has been defined as a small, quickly constructed, temporary, tactical-support airfield, capable of sustaining operations of the Marine Corps' modern jet aircraft which employ assisted takeoffs and arrested landings.

2. From the standpoint of load-carrying capability, the criterion established by NAEC for a satisfactory mat is that it remain serviceable with minimum maintenance for 1600 aircraft operation cycles during a 30-day period when placed on a subgrade having a CBR of 10 or less. (A cycle is one takeoff and one landing.) The heaviest proposed Marine aircraft that will utilize SATS weighs 60,000 lb (27,000 lb per main gear wheel) and is equipped with 30-7.7, 18-ply rating tires inflated to 400 psi. Thus, the test load for the various mats being considered by NAEC for use in SATS has been standardized as a 27,000-lb single-wheel load with 30-7.7, 18-ply tires inflated to 400 psi. The test requirement for the mat is that it remain serviceable with minimum maintenance for (a) 1600 passes of the test load applied in a single path (one tire print width) when supported on a subgrade having a CBR of 10 or less, and (b) 188 coverages (equivalent to 1600 cycles) of the same loading uniformly distributed over a 10-ft-wide traffic lane. The single-path traffic is designed to simulate takeoff runs in which a catapult system is employed, and the uniform-coverage traffic is used to simulate landings and normal takeoffs in which no catapult is used.

3. Early in the test program an aluminum mat developed by Harvey Aluminum Co. (hereinafter referred to as Harvey), Torrance, Calif., and

tested at WES fulfilled the NAEC test requirements (see WES Miscellaneous Paper No. 4-615, Development of CBR Design Curves for Harvey Aluminum Landing Mat, dated January 1964). Subsequently, the design for the Harvey aluminum mat was standardized by NAEC, and the mat was designated as Airfield Matting No. 2 (AM2). Since standardization of the AM2 design, several tests have been conducted at WES on small quantities of production mat fabricated under different procurement contracts (see report titles on the inside of the front cover). Although there has been considerable variation in the performance of the various lots of AM2 tested, they have all met the minimum requirements for satisfactory performance when placed on a subgrade having a CBR of 10. The most recent test of AM2, prior to the test reported herein, was of a Harvey modified AM2 design. The modification involved only the end joints, which were connected to the main extrusions by a tongue-and-groove type junction as opposed to the face-to-face connection used in the standard AM2. The performance of the modified mat was superior to that of any of the standard mats previously tested. Therefore, NAEC incorporated the modified joint detail in its specifications for future mat procurements.

4. Along with the mat development program, NAEC has developed a catapult system for assisted takeoffs on SATS. The present concept for assisted takeoffs employs a CE-type catapult with a guide rail placed in the runway in conjunction with the landing mat.

Objectives and Scope of Investigation

5. The initial objective of this study was to evaluate the performance of the guide rail in conjunction with a new Navy procurement of AM2 from Kaiser Aluminum Co. (hereinafter referred to as Kaiser) under accelerated traffic tests of simulated aircraft loadings. It was specifically desired to determine the effect of subgrade strength (CBR) and soil type on the performance of the guide rail and the AM2. During the tests, the objectives were broadened to (a) obtain some comparative performance data for the Kaiser AM2 and the Harvey modified AM2 when used in conjunction with the guide rail, and (b) evaluate the subgrade strength

requirements for the Kaiser AM2 when used without the guide rail.

6. The objectives of the study were accomplished by:

a. Conducting accelerated traffic tests on a specially prepared test section consisting of one item of loose sand and three items of heavy clay soil constructed to various CBR values and surfaced with the Kaiser AM2 in conjunction with a guide rail and without a guide rail.

b. Repeating the traffic described in subparagraph a over one test lane on the four items surfaced with Harvey modified AM2 used in conjunction with the guide rail.

c. Measuring the CBR, density, and water content of the subgrade materials before and after traffic.

d. Observing the behavior of the mat and guide rail during traffic.

7. This report describes the guide rail, landing mats used, test section, tests conducted, results obtained, and presents an analysis of the test data.

Definition of Traffic Terms

8. For clarity, various traffic terms used in this report are defined below:

a. Cycle. A cycle is one takeoff and one landing of an aircraft. For this study, a cycle was considered to be one round trip or two passes on a runway or taxiway.

b. Pass. A pass is one traverse of a load wheel over a given length of runway, taxiway, or test-section surface. In this investigation, load repetitions applied in a single path (one tire print width) are referred to as passes. The takeoff loading repetitions involved in 1600 cycles of aircraft operations where a catapult system is used for assisted takeoffs are simulated by 1600 passes of traffic applied in a single path.

c. Coverage. One coverage consists of one application of a wheel of an aircraft or test load cart over each point in the area of the traffic lane. In this investigation, load applications distributed uniformly over a 10-ft-wide traffic lane are referred to as coverages.

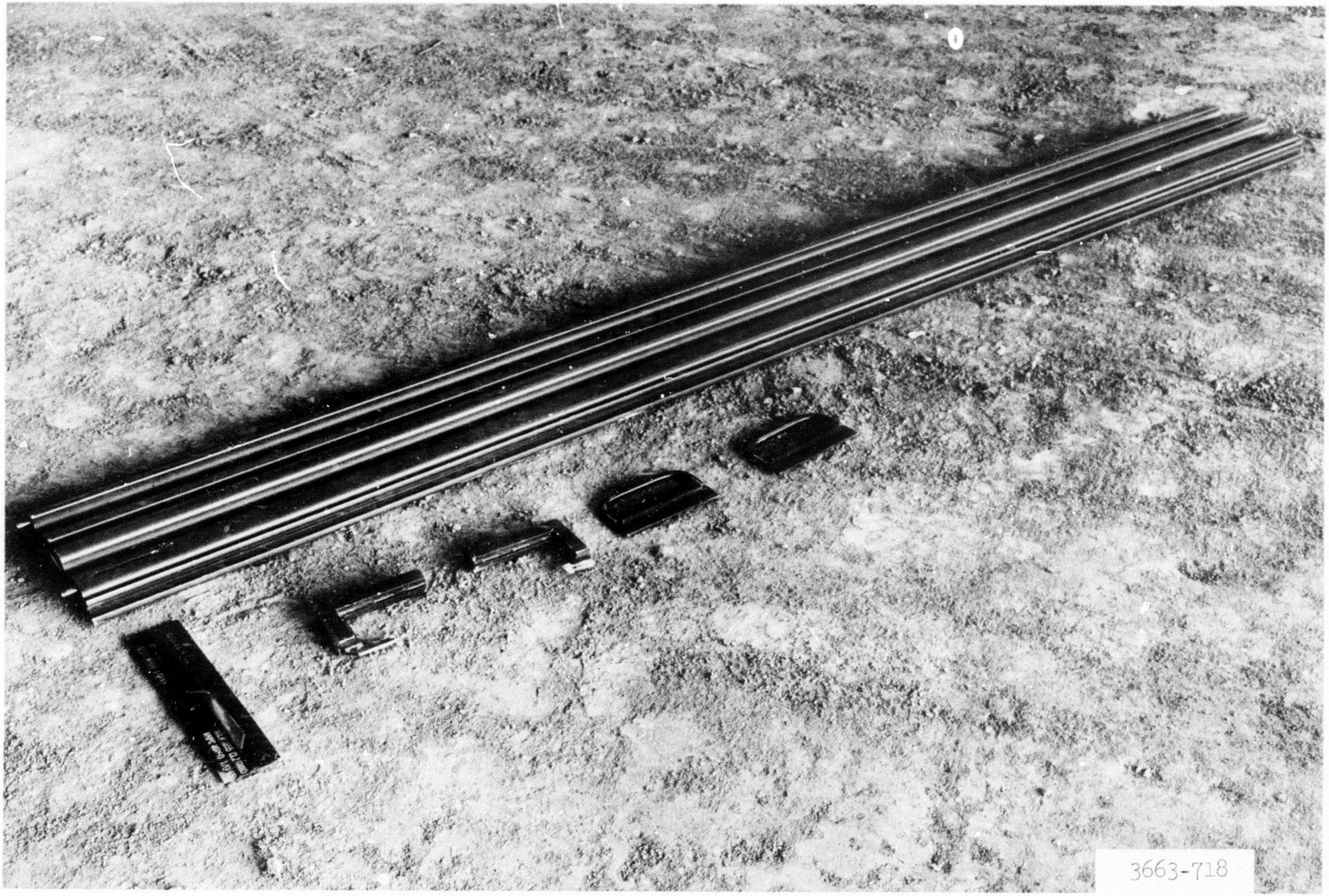


Fig. 1. Section of guide rail and special tools for assembly

PART II: GUIDE RAIL, MAT, TEST SECTION, AND TEST LOAD CART

Guide Rail

9. The guide rail used in this test was designed and constructed by All American Engineering Co., Wilmington, Del., and was especially designed for use with AM2. It was extruded from aluminum alloy in sections 9 and 10 ft in length, with an overall width of 11-3/4 in. The WES received 15 sections of guide rail (14 were 10 ft in length and one was 9 ft in length) to be used in this test. The 10-ft sections had an average weight of 130 lb each, and the 9-ft section weighed 116.5 lb. A 10-ft section of guide rail along with special tools used for alignment and assembly is shown in fig. 1. In use, the individual sections of guide rail are joined together at the ends by a spring pin, which is an integral part of the guide rail. Each side of the guide rail is constructed with underlay connectors which couple to the end joints of the AM2. After the guide rail has been placed in proper alignment in the longitudinal direction on the runway, the AM2 is connected to it on each side and laid with the long axis of the mat perpendicular to the guide rail. A schematic drawing of a cross section of guide rail with mat and guide rail connection is shown in fig. 2.

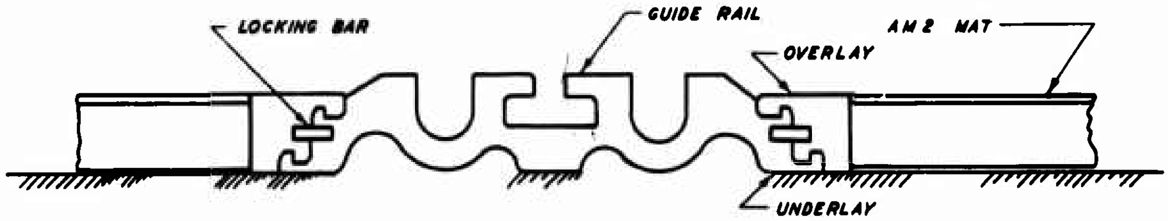
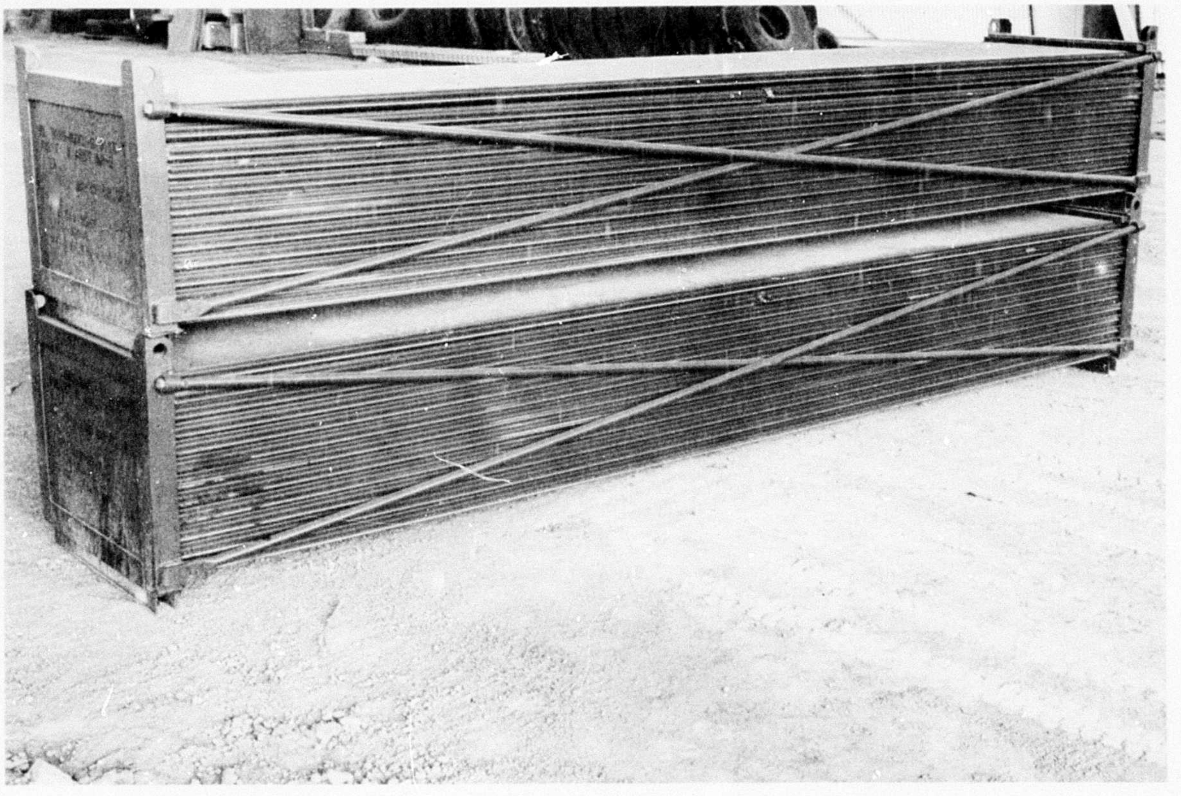


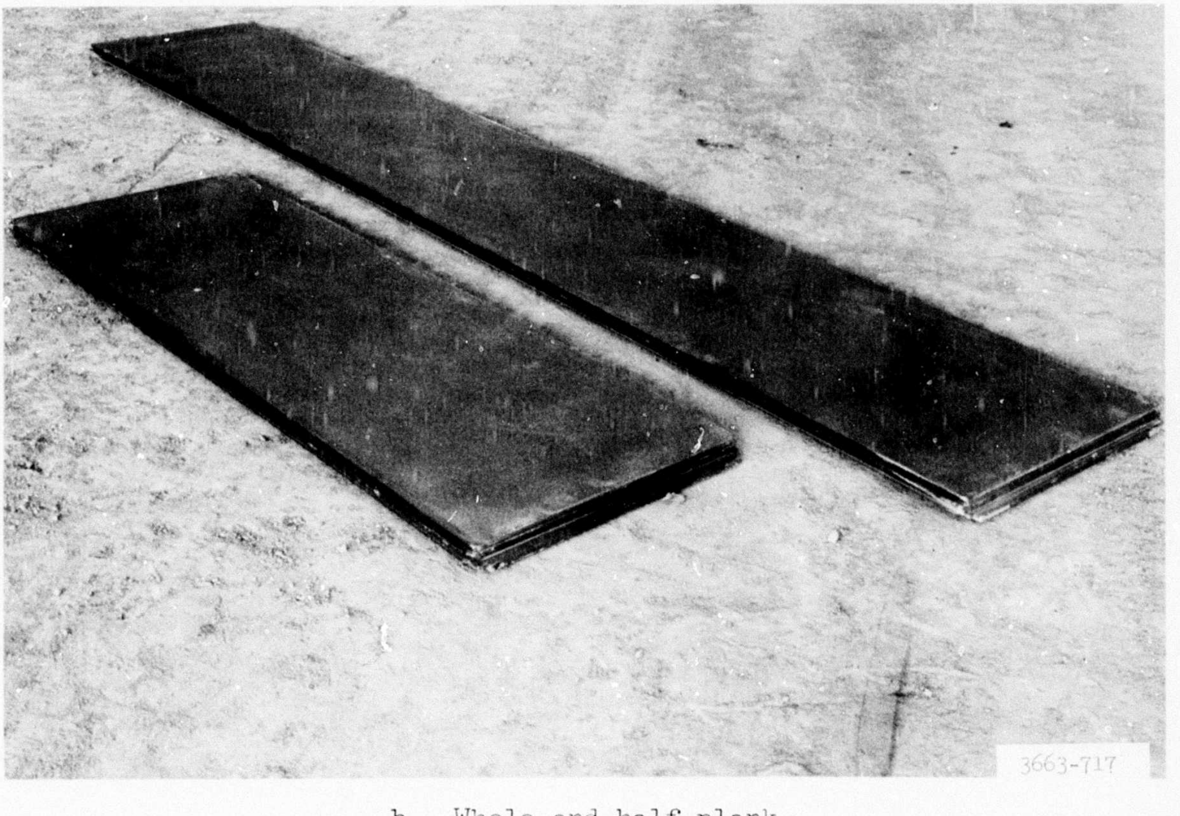
Fig. 2. Schematic diagram AM2-guide rail connection

Mat

10. The Kaiser AM2 used in this st'' was procured under specifications requiring the modified end joint. The mat was fabricated by Kaiser in a single extrusion, except for the end joints which were extruded separately and welded onto the body of the panels by Washington Aluminum Co.



a. Mat pallets



b. Whole and half plank

Fig. 3. Pallets, and a whole and half plank of Kaiser AM2

(hereinafter referred to as Washington), Enterprise, Ala. Fifteen pallets of the mat were received at WES. Each pallet consisted of 11 whole planks that were approximately 12 ft long and 2 ft wide and two half planks that were 6 ft long and 2 ft wide. Included in the shipment were locking bars for connecting the end joints. The average thickness of the mat planks was 1-1/2 in. The top surface of all the mat planks was coated with an antiskid compound. The average weight of the whole planks (2 by 12 ft) was 144.5 lb, and the average weight of the half planks was 72.8 lb. Fig. 3a shows two of the mat pallets, and fig. 3b shows a whole and a half mat plank. The Harvey modified AM2 used in this study was used mat which had been recovered from a previous test, the results of which were reported in an earlier report of this series (WES MP No. 4-747).

Test Section

Description

11. The traffic tests were conducted at the WES on a special test section which was constructed and tested under shelter in order to control the subgrade water content and strength. The test section (plate 1) consisted of four test items, each approximately 24 ft wide. Item 1 was 30 ft long, and items 2, 3, and 4 were each 40 ft long. Item 1 was constructed of a loose sand, and items 2, 3, and 4 were constructed of a heavy clay soil. Classification data for the subgrade soils are shown in plate 2.

Subgrade construction

12. The test subgrades were to be constructed to a total thickness of 24 in.; therefore, the existing material at the test site was excavated to a depth of 24 in. below finished grade, and the excavation was backfilled with the special test soil. The soil at the bottom of the excavation was a lean clay having an approximate CBR value of 10. Item 1 consisted of a 24-in. thickness of loose sand. The sand was end-dumped from trucks, spread, and compacted in a single lift with only a few coverages of a D4 tractor. The subgrades for items 2, 3, and 4 were to be constructed of the heavy clay soil at water contents that would result in CBR values of approximately 10, 6, and 4, respectively, after compaction.

The soil for each test item was processed separately to the desired water content, hauled to the test site by truck, spread, and compacted in 6-in.-thick lifts. Compaction of each lift was accomplished by the application of eight coverages of a four-wheel, rubber-tired roller loaded to 40,000 lb and with tires inflated to 90 psi. The surface of each lift was scarified prior to the placement of the next lift. After placement and compaction of the fourth and final lift, the surface of the subgrade was fine-bladed to grade by a motor patrol. The sand in item 1 was left slightly crowned and higher than the other items, as considerable settlement under traffic was anticipated.

Guide Rail and Mat Placement

13. The guide rail was placed along the center line of the test section. A string line was first placed for alignment, and the guide rail was laid along the string line. Two sections of the guide rail in position to be connected are shown in fig. 4. The rubber strip between the two sections of guide rail is used as a seal under the joint and as a spacer to form an expansion joint between the two sections. The two sections are connected by the spring pins shown in fig. 4. The tools shown on top of the guide rail were used for driving the spring pins from the male end of the joint into the female end for connection and vice versa for disassembly. The tools shown on each side of the joint were used to obtain proper alignment. The guide rail was laid from the north end of the test section (item 4) to the south end. The 9-ft-long section was laid first, then the 10-ft-long sections. This laying procedure was followed so that the joints of the guide rail would fall at the midpoints of the adjacent 2-ft-wide AM2 planks.

14. The AM2 was laid on both sides of the guide rail (fig. 5). Fifteen runs of mat were used in surfacing item 1, each run consisting of two whole mat planks, one on each side of the guide rail. A view of AM2 planks in place on both sides of the guide rail with locking bars partially inserted is shown in photograph 1. For items 2, 3, and 4, a full mat plank was used for each run on the west side of the guide rail, while on

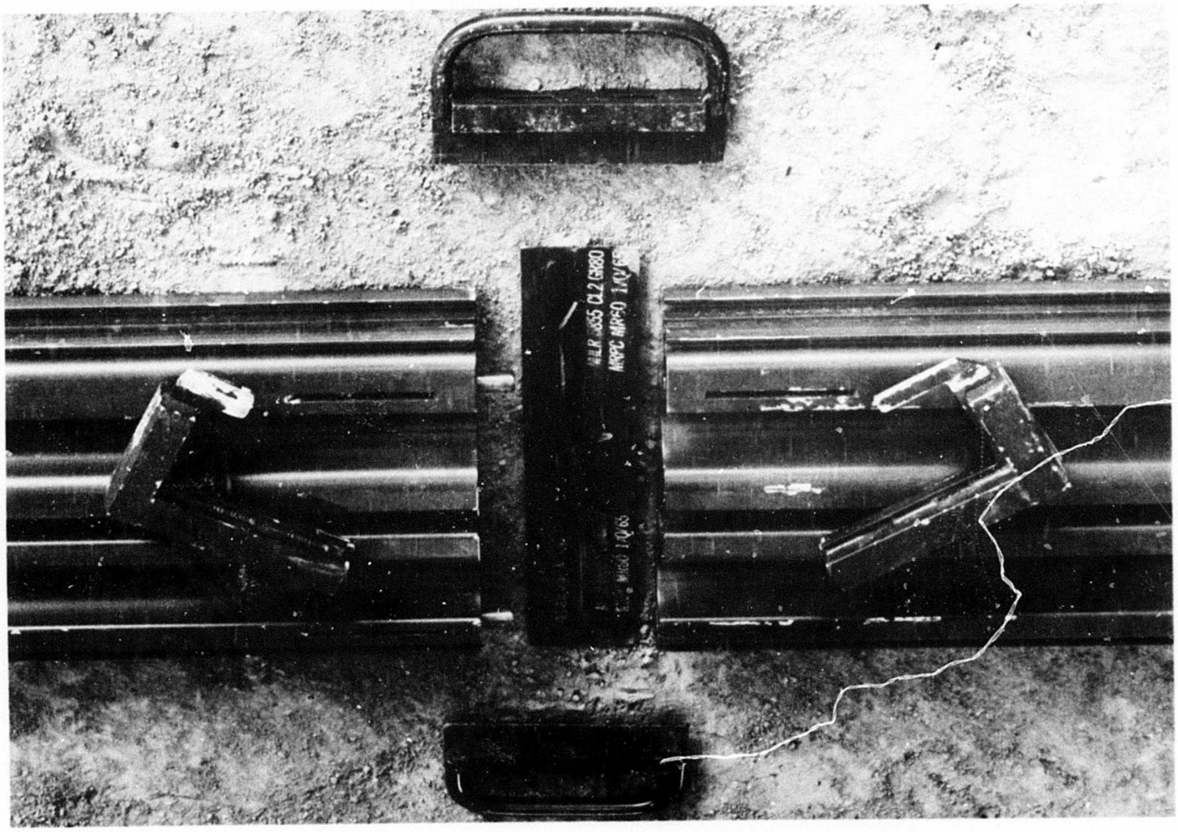


Fig. 4. Two sections of guide rail in position for connection, and connecting and aligning tools

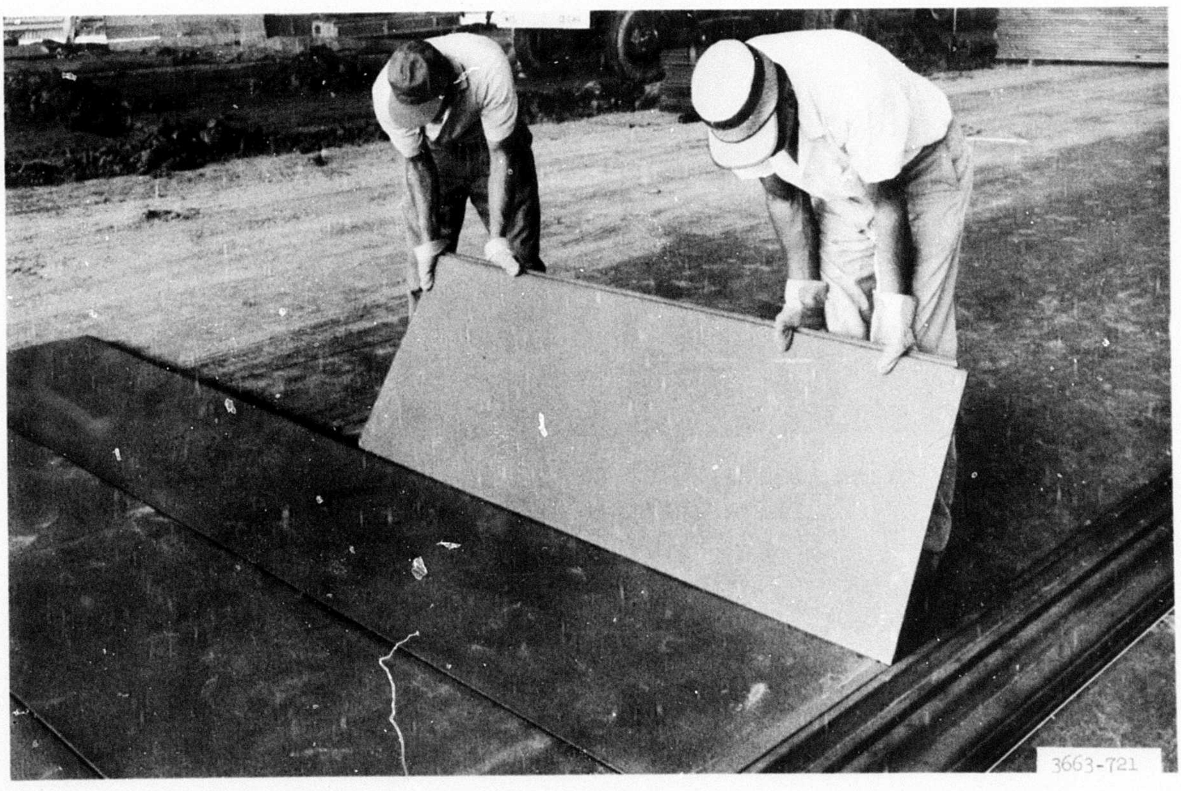


Fig. 5. Mat placement in progress

the east side of the guide rail, every other mat run contained a half plank that was placed next to the guide rail plus one whole plank that extended 6 ft beyond the east edge of the test section, as shown in photograph 2. This laying pattern was used to simulate the pattern that would normally be used on a runway, and resulted in a staggered joint pattern.

15. In preparation for the uniform-coverage test lane, all mats and the guide rail were taken up, the surface of the subgrade was fine-bladed, and the mat was relaid without the guide rail, as indicated in fig. 2 of plate 1.

Test Load Cart

16. A specially designed single-wheel test cart (fig. 6), loaded to 27,000 lb, was used in the traffic tests. It was fitted with an outrigger wheel to prevent overturning and was powered by the front half of a four-wheel-drive truck. The load cart was equipped with a 30-7.7, 18-ply-rating tire inflated to 400 psi, which gave a tire contact area of about 82 sq in. and an average contact pressure of 330 psi.

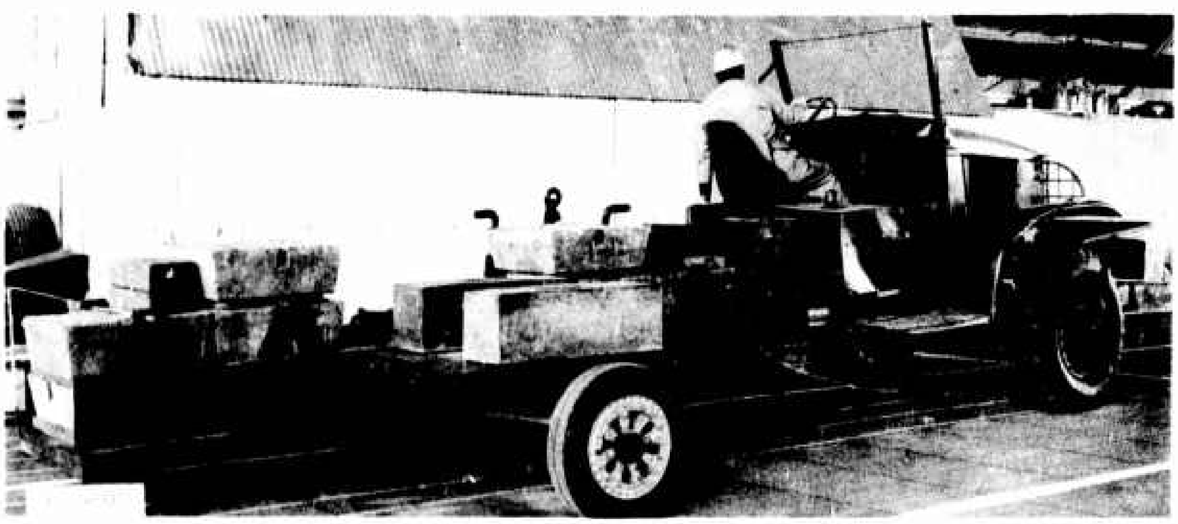


Fig. 6. Test cart with 27,000-lb single-wheel load with tire inflated to 400 psi

PART III: TESTS AND RESULTS

Traffic Tests

Single-path traffic

17. In aircraft launching operations with the CE-type catapult and guide rail system, the aircraft will be launched from a fixed position astraddle the guide rail. The nose gear of the plane will be centered on the guide rail and will rest on a dolly. The wheels of the dolly will run along each side of the guide rail at the junction of the guide rail and the mat. The main gear wheels of a given type plane will run in the same path, one on each side of the guide rail, during each takeoff. The single-line traffic applied in test lanes 1 and 2 was designed to simulate take-off operations. As can be noted from the layout shown in plate 1, the center line of test lane 1 was located on the west side of the guide rail at its junction with AM2. This was done to simulate the loading from the nose gear. The center line of test lane 2 was located 7.5 ft east of the center line of the guide rail to simulate the loading and position on the mat of one of the main gear wheels. Test lane 1a was identical with test lane 1, except that the Kaiser AM2 was removed from the west side of the guide rail and replaced with used Harvey modified AM2, and the traffic was applied on the Harvey mat.

18. In the application of traffic to test lanes 1, 2, and 1a, the test load cart described previously (paragraph 16) was driven forward and backward in the same track with the center of the load wheel located at the center of the traffic lane. Traffic was continued until mat failure developed or to a maximum of 1600 passes, whichever occurred first.

Uniform-coverage traffic

19. The uniform-coverage traffic was conducted on the Kaiser AM2 laid without guide rail. Because the Kaiser mat had already been subjected to single-line traffic, it was relaid in preparation for the uniform-coverage traffic on test lane 3 with the ends of the mat planks reversed so that the portion of mat to be trafficked had not been subjected to prior traffic. The laying pattern for the mat and the location of the

traffic lane are shown in fig. 2 of plate 1.

20. In the application of traffic, the test load cart was driven forward and then backward the length of the test section with the path of the cart shifted laterally about 7.3 in. (one tire-print width) on each successive forward pass. This procedure resulted in two complete coverages over the traffic lane each time the load cart was maneuvered from one side of the traffic lane to the other. Traffic was continued until the mat failed or until a total of 188 coverages had been completed.

Soil Tests and Miscellaneous Observations

21. Water content, density, and in-place CBR tests were conducted prior to and at the end of traffic in each test item of each test lane. These tests were made at depths of 0, 6, and 12 in. At least three tests were made at each depth, and the data obtained from the tests are summarized in table 1. The values listed in the table corresponding to the various depths are averages of the values measured at each particular depth.

22. Visual observations of the behavior of the test items and other pertinent factors were recorded throughout the traffic testing period. These observations were supplemented by photographs. Level readings were taken prior to and at intervals during traffic to show the development of permanent deformation and deflection of the mat under the wheel load.

Behavior of Guide Rail and Mat Under Traffic

Failure criteria

23. The criteria for mat failure were the same as those used previously in other tests of this series. These failure criteria were based primarily on mat breakage. It was assumed that a certain amount of maintenance could be performed in the field during actual usage and that minor metal or weld breaks could be repaired rather easily. However, when an end-connector joint broke off or a mat core failed completely, the mat plank would be considered failed and should be replaced. Partial core

failures did not immediately result in an unserviceable plank, but in some cases the failure progressed to the point that the plank was considered a tire hazard and was considered failed. It was considered feasible to replace up to 10 percent of the mat planks with new mat during the design service life of the runway. However, to replace more than 10 percent of the planks, would require excessive maintenance effort. Therefore, for the test section, it was assumed that up to 10 percent of the mat planks could be replaced; when an additional 10 percent (a total of 20 percent) of the planks had failed, the entire test item was considered failed.

24. There are no established criteria for judging failure of the guide rail. However, the behavior of the guide rail was observed during the traffic period and the observations are discussed along with the observations of the mat behavior.

Test lane 1,
guide rail and Kaiser AM2

25. Visual observations. After the first few passes of the load wheel, small hairline cracks were noted on several mat planks adjacent to the guide rail where the AM2 end connector was welded to the plank extrusion. By the end of 11 passes, the cracks were quite noticeable in three planks of item 4 (the low-strength clay item), and by 20 passes, the end-connector joints had completely separated on four test planks due to weld failure, and eight other joints were badly cracked. A close-up view of two of the failed joints is shown in fig. 7. A general view of item 4 at the end of 20 passes is shown in photograph 3, which shows that the general appearance of the mat and guide rail at the end of 20 passes was fairly good; the mat surface remained smooth and the bodies of the planks were not damaged. However, as the load passed over the failed joints, the planks deflected downward below the sheared end connector which was still connected to the guide rail. This resulted in a tire hazard; therefore, item 4 was considered unserviceable at the end of 20 passes.

26. Test items 1, 2, and 3 were still in good condition after 20 passes with only two minor weld cracks noted in item 3 and one in item 2. Prior to continued traffic on these items, the Kaiser AM2 was removed from the west side of the guide rail on item 4 and replaced with

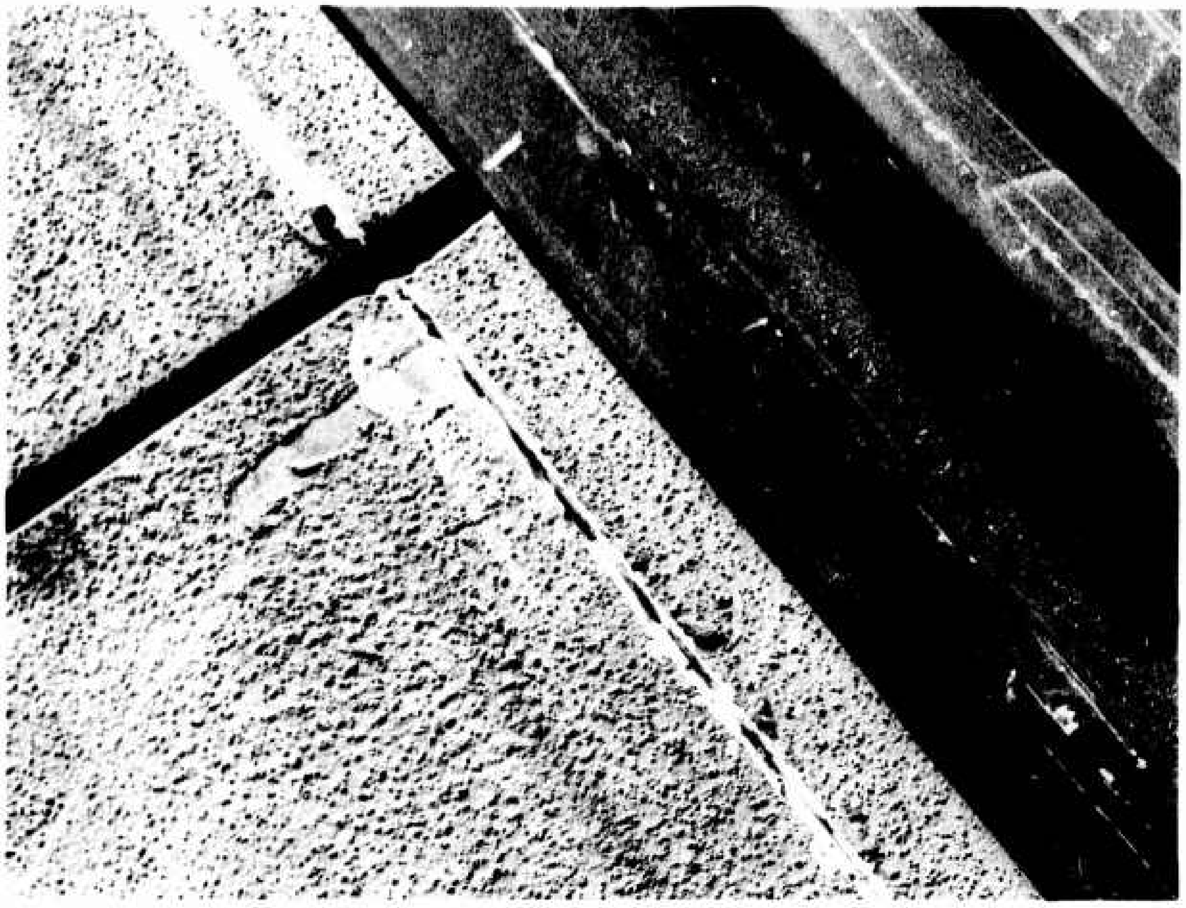


Fig. 7. Close-up of end-joint failure, lane 1, item 4

16 runs of Harvey modified AM2 and two runs of Kaiser 4- by 4-ft planks of aluminum honeycomb mat that has the same type connectors as the AM2.

27. As traffic continued, weld failures developed quite rapidly in items 1, 2, and 3. By the end of 70 passes, four end joints had completely separated in item 3. At this point the item was considered failed. However, traffic was continued to 80 passes, resulting in the complete separation of eight joints. At this stage of traffic, six joints in item 1 (sand subgrade) and three joints in item 2 (high-strength clay subgrade) had failed. Traffic was continued on item 2 to 100 passes, at which time the end connectors of five additional planks separated, making a total of eight failed joints. At this stage, the entire test lane, with the exception of the Harvey and Kaiser mats in item 4, was considered unserviceable. General views of test items 1, 2, and 3 at failure are shown in photographs 4, 5, and 6, respectively. All mat failures were of the same

type and were caused by separation of end joints from the body of the mat planks at the weld seams. A close-up of joint failures in test item 3 is shown in photograph 7.

28. Traffic was continued for a total of 100 passes on the Harvey AM2 and Kaiser 4- by 4-ft mats, which were placed in item 4 after the failure of the Kaiser AM2 at 20 passes. These mats withstood the 100 passes of traffic with no evidence of mat distress, as indicated in photograph 8.

29. The performance of the guide rail was considered quite satisfactory during all traffic applied on lane 1. The rail showed no evidence of any structural damage; however, it did show a slight tendency to tilt. This tendency was most pronounced in item 1, the loose sand subgrade. The tilting was the result of the tracking pattern being used wherein only one side of the guide rail was loaded, and probably would not occur under normal aircraft operations.

30. Permanent deformations. Profile plots showing permanent deformation of mat as determined from level readings taken prior to and at various traffic intervals in lane 1 are shown in plate 3. These data indicate that the greatest settlement occurred in item 1, which averaged about 0.6 in. at the end of 80 passes of traffic. The settlement in items 2, 3, and 4 was about the same at the end of 20 passes of traffic and averaged about 0.2 in. As can be noted, a slight increase in settlement occurred with an increase in traffic passes on items 2 and 3. Typical cross-section plots showing deformation across the traffic path in each test item are shown in plate 4.

31. Elastic deflection. Deflections of the mat surface under load, determined from level readings, are shown in plate 5, which indicates the elastic deflection or rebound of the mat as the wheel load moved over the surface of the mat. Data are shown for conditions at the start of traffic and at the end of traffic. These data show that the greatest mat deflection occurred in item 1 and was about 1.3 in. at the end of 80 passes of traffic. Also, the difference between the deflection before and after traffic was greatest for item 1.

Test Lane 2,
<u>guide rail and Kaiser AM2</u>

32. <u>Visual observations.</u> The mat and guide rail performed quite satisfactorily during the first 500 passes of the load wheel with no distress of any type noted. A general view of the test lane after 500 passes of the load wheel is shown in photograph 9. As traffic was continued, there was a slight shifting of the mat and the guide rail to the east, and the mat on the east side of the guide rail was also moving slightly to the north. This movement resulted in a slight bow in the guide rail and mat. Photograph 10 is a general view of the test lane at the end of 1000 passes, which may be compared with that in photograph 9. In photograph 10, a slight bow can be noted in the painted guide lines on the mat surface, as well as a broken guide line on the left side of the guide rail. This broken line gives an indication of the magnitude of lateral shifting of the guide rail as the mat planks on the left side of the guide rail, which were still connected to the guide rail, shifted with the mat, and the planks with end joints broken from traffic in lane 1 did not move.

33. The first evidence of distress in the body of the mat planks was also noted at about 1000 passes of the load wheel. The distress was evidenced by depressions or dished areas on the surface of the mat planks, which normally developed first on the female edge of the plank, as indicated in photograph 11. This depression was an indication of structural failure within the mat core. As traffic was continued to a total of 1600 passes, the core failures developed quite rapidly in all test items, especially in items 1 and 4. By the end of 1600 passes, the riding surface was quite rough. In addition to the core failure, a number of weld cracks developed at the end joint 1.5 ft west of the center line of the traffic path, with two joints in item 4 completely separating. One of the weld failures is shown in fig. 8. A general view of the test lane at the completion of 1600 passes of traffic is shown in photograph 12. A close-up view showing the condition of the mat in test item 4 is shown in photograph 13. After removal of the mat from the test section, several planks were cut to determine the extent of core failures. Fig. 9 shows a

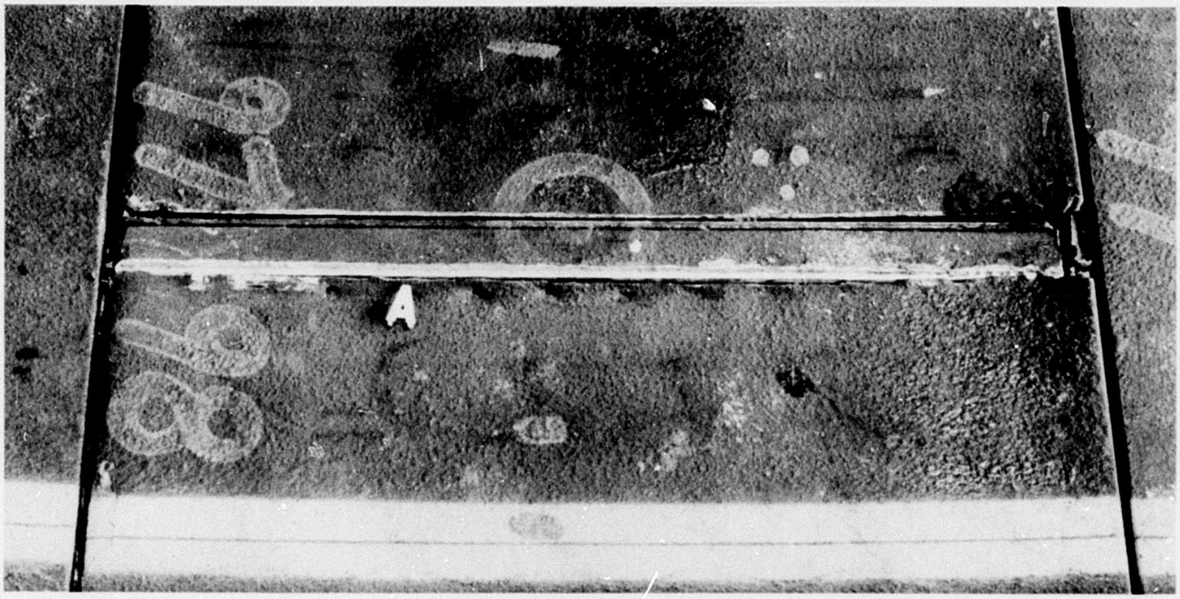


Fig. 10. Close-up of end-joint failure in item 4, lane 3

43. As traffic was continued on items 1, 2, and 3, similar end-joint weld failures developed in items 2 and 3, but at a more rapid rate in item 3. After 70 coverages, the end-joint welds on seven planks in item 3 had completely failed, and traffic on this item was discontinued. A general view of item 3 at the end of traffic is shown in photograph 23. Traffic was continued on items 1 and 2 to a total of 188 coverages, at which point nine end-joint weld failures had developed in item 2, but no failures or weld cracks had developed in any of the mat planks in item 1.

44. During the application of the uniform-coverage traffic in lane 3, there was considerable lateral shifting of the mat planks, even though lead weights had been placed along each edge of the test section in an effort to maintain true alignment of the mat. The magnitude of the lateral shifting can be noted from the broken guide lines in photograph 24, which is a general view of items 1 and 2 at the end of traffic.

45. Permanent deformation. Plots of permanent deformation of the mat along the center line of the test lane are shown in plate 11. Typical cross sections for each test item showing permanent deformation are shown in plate 12. These data show that the average total permanent deformation in item 1 was about 1 in.; whereas for items 2, 3, and 4, the deformation was quite small, with an average of about 0.1 in.

cross-section view of structural core failures in three planks.

34. Permanent deformation. Profile plots showing permanent deformation of the mat along the center line of traffic lane 2 after various intervals of traffic are shown in plate 6. These data show that the greatest deformation developed in item 1 (sand subgrade) and the least deformation in item 2 (high-strength clay subgrade). Also, the deformation increased with an increase in load repetitions for all items, except item 2 where only minor deformations developed, with little or no change between 1000 and 1600 passes of the load wheel. Typical cross sections indicating the deformation across the traffic path after various intervals of traffic are shown in plate 7.

35. Elastic deflection. Measurements of mat deflection under load for the various items in lane 2 indicated about the same pattern and magnitude of elastic deflection as that developed in lane 1 (see paragraph 31). The maximum deflection at the end of 1600 passes was measured as 1.1, 0.5, 0.6, and 0.9 in. for test items 1, 2, 3, and 4, respectively.

36. Mat bridging. As the mat was being removed from the test section following traffic in lane 2, a slight depression or rut was observed in the subgrade along the traffic path of lanes 1 and 2. Although the mat was slightly deformed, it did not completely conform to the deformation of the subgrade and tended to bridge the rut in the subgrade, as indicated in photograph 14. In order to show the magnitude of the subgrade deformation and mat bridging, level readings were obtained on the surface of the subgrade across the test lanes at the same locations where the final level readings on the surface of the mat at the end of traffic were obtained. From these readings, cross sections were plotted showing the relative elevation of the top and bottom of the mat and the top of the subgrade at the end of traffic. These plots for each of the four test items are shown in plate 8. Examination of these data reveals that the greatest subgrade deformation and bridging of mat occurred in item 1, but some degree of bridging occurred in all test items. Due to the bridging of mat over depressed areas in the subgrade, the

elastic deflection values measured on the surface of the mat, as discussed previously, apply only to the mat itself and not to the soil underneath.

Test lane 1-a,
guide rail and Harvey AM2

37. Preparation of lane. As previously stated, test lane 1-a was located in the same position in the test section as test lane 1, the only difference between the lanes being the type of mat used. Prior to this test, the Kaiser AM2 and guide rail were completely removed, and the subgrade was bladed to eliminate the depressions which had resulted from previous traffic in lanes 1 and 2. The guide rail was then relaid in the initial position and the section was resurfaced with mat. Kaiser AM2 was used on the east side of the guide rail, and Harvey modified AM2, with the exception of eight mat planks in item 4, was used on the west side of the guide rail where the traffic lane was located. In item 4, two 4- by 4-ft planks of Kaiser honeycomb mat were placed together with six planks of old AM2 without the modified joint (source unidentified) which were used by mistake. All mat used on the west side of the guide rail was old and had been used in previous tests, but it appeared to be in good condition. A general view of the test section prior to traffic is shown in photograph 15.

38. Visual observations. During the first few passes of the load wheel, cracks developed in end-joint welds in three of the six old AM2 planks without the modified end joints, and after 17 passes, these joints had completely separated. After 40 passes, all six of the old planks had failed. All other mat in the test lane was in good condition. After 200 passes, four of the Harvey modified AM2 planks in item 4 had failed because of weld failures at end joints. A general view of the failed end joints is shown in photograph 16. All other mat in the test lane was in satisfactory condition. The two Kaiser 4- by 4-ft planks of honeycomb mat in item 4 were still in good condition at the end of 200 passes; however, these planks were located at the extreme north end of item 4 and could not be subjected to further traffic without continuing traffic over the failed

AM2. The joint failures in the AM2 had created a hazard to the test load tire; therefore, no further traffic was applied on any of the mat in item 4.

39. During the first 200 passes of the load wheel, some lateral shifting of the mat and guide rail occurred, resulting in disalignment of the guide rail. Therefore, prior to continuing traffic on items 1, 2, and 3, ballast weights were placed along each edge of the mat, as shown in photograph 17, to prevent further shifting of the mat and guide rail.

40. As traffic was continued, weld cracks began to develop in some planks of all test items. After 350 passes, the end joints had failed in eight planks in item 3 (photograph 18). At this point traffic was discontinued on this item. At this stage of traffic, only one joint failure had developed in item 1 and no failures had developed in item 2. After 800 passes, five end joints had failed in both items 1 and 2 with failure imminent in a number of other planks. Traffic was discontinued at this point. A view of items 1 and 2 at the end of traffic is shown in photographs 19 and 20, respectively. The traffic applied in the test lane resulted in no visual damage to the guide rail.

41. Permanent deformation. Plots showing permanent deformation of the mat along the center line of the test lane are shown in plate 9. Typical cross sections for each test item showing permanent deformation are shown in plate 10. These data show about the same pattern and magnitude of deformation as that which developed in lane 1 (paragraph 30).

Test lane 3,
Kaiser AM2 without guide rail

42. Visual observations. A general view of the test section prior to traffic is shown in photograph 21. The first evidence of mat distress was a weld crack which developed at one of the end joints in item 4 and was noted at the end of 10 coverages of traffic. After 20 coverages, this weld had completely failed, and cracks were noted at the joints of seven other planks. After 40 coverages, the end joints of eight planks in item 4 had completely failed. At this point traffic was discontinued. A general view of item 4 at the end of traffic is shown in photograph 22. A close-up of one of the end-joint failures is shown in fig. 10.

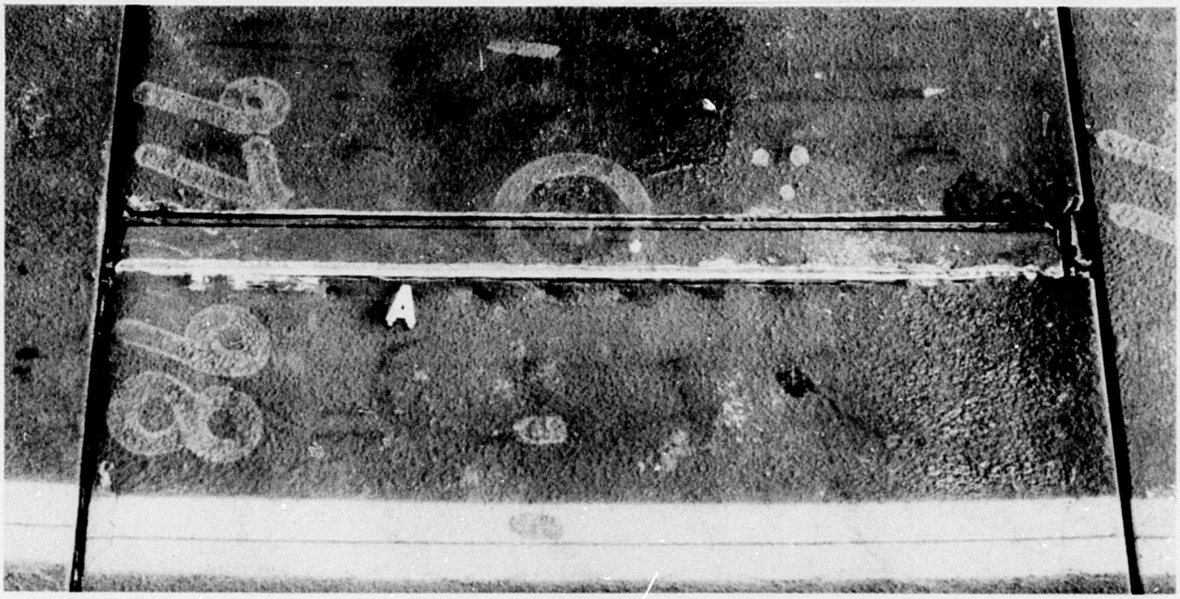


Fig. 10. Close-up of end-joint failure in item 4, lane 3

43. As traffic was continued on items 1, 2, and 3, similar end-joint weld failures developed in items 2 and 3, but at a more rapid rate in item 3. After 70 coverages, the end-joint welds on seven planks in item 3 had completely failed, and traffic on this item was discontinued. A general view of item 3 at the end of traffic is shown in photograph 23. Traffic was continued on items 1 and 2 to a total of 188 coverages, at which point nine end-joint weld failures had developed in item 2, but no failures or weld cracks had developed in any of the mat planks in item 1.

44. During the application of the uniform-coverage traffic in lane 3, there was considerable lateral shifting of the mat planks, even though lead weights had been placed along each edge of the test section in an effort to maintain true alignment of the mat. The magnitude of the lateral shifting can be noted from the broken guide lines in photograph 24, which is a general view of items 1 and 2 at the end of traffic.

45. Permanent deformation. Plots of permanent deformation of the mat along the center line of the test lane are shown in plate 11. Typical cross sections for each test item showing permanent deformation are shown in plate 12. These data show that the average total permanent deformation in item 1 was about 1 in.; whereas for items 2, 3, and 4, the deformation was quite small, with an average of about 0.1 in.

46. Elastic deflection. Plots of the elastic deflection of mat under load for each item of the test lane are shown in plate 13. These data indicate higher mat deflection in item 1 than in the other test items. However, as was the case for lanes 1 and 2, most of this deflection was caused by the mat's bridging depressed areas in the subgrade; therefore, the data do not indicate the magnitude of deflection of the subgrade.

Summary and Analysis of Test Results

Single-path traffic

47. Test results. The test results for lanes 1, 2, and 1-a, where traffic was applied on the mat in conjunction with the guide rail, are summarized in table 2. Included in the table are types and quantitites of the mat planks subjected to traffic, types and rated CBR's of the subgrades, and data on mat breakage and deflection at various stages of traffic. The last column in table 2 indicates the rating of the various test items based on the failure criteria described in paragraph 23.

48. The rated CBR for the clay subgrades, items 2, 3, and 4, is based on the numerical average of the CBR values measured at 0-, 6-, and 12-in. depths prior to and at the end of the traffic period (see table 1). For the sand subgrade in item 1, the initial CBR prior to traffic was generally quite low due to the looseness of the sand. However, as traffic was applied, the sand densified and the CBR values increased considerably. Because of the appreciable change in the strength of the sand during the traffic period, it is difficult to assign a specific rated CBR value to the sand; therefore, the range of CBR values as determined before and at the end of traffic is listed in table 2.

49. As can be noted in table 2, all items in lane 1 where traffic was applied at the junction of guide rail and Kaiser AM2 failed within 100 passes of the load wheel. These failures were caused by shearing in the weld seams where the end connectors were welded onto the main plank extrusions. A comparison of the behavior of the different test items. reveals that the number of passes of the load wheel required to produce

failure increased with an increase in subgrade strength.

50. In lane 2, where the center line of traffic path was located 7.5 ft east of the center line of the guide rail, all items of the test lane withstood a total of 1600 passes of the load wheel. However, partial core failures developed in some planks of all test items except item 2. These failures were most pronounced in item 4 and, in addition, two end-joint weld failures developed in item 4. At the end of the traffic period, all test items were considered to be satisfactory, except item 4 which was rated as border line.

51. The only difference between lane 1 and 1-a was the type of mat used. As can be noted in table 2, mat failure developed in all items of lane 1-a within 800 passes of the load wheel. The failures in the Harvey modified AM2 were of the same type as that previously described for the Kaiser mat.

52. Service life. A plot of CBR versus passes for both the Kaiser AM2 and the Harvey modified AM2 is shown in plate 14. The lines were drawn to best fit the failure points of the clay subgrade test items. The slope of the lines indicating the relation between CBR and passes is about the same for both mats. However, as can be noted, the service life of the Harvey modified AM2 was about five times greater than that of the Kaiser mat placed over subgrades of equal strength.

53. The lowest subgrade strength in lane 2 was in item 4 where the rated CBR was 5. Since the performance of this item was considered border line, or at an incipient failure at the end of 1600 passes, a CBR of 5 is considered to be the minimum subgrade strength upon which the Kaiser AM2 will sustain 1600 passes of the 27,000-lb single-wheel load with a tire inflation pressure of 400 psi when applied in a single path 7.5 ft from the guide rail.

54. As previously discussed, the traffic applied on the AM2 in conjunction with the guide rail caused no structural damage to the guide rail. However, there was some slight lateral shifting of the mat and guide rail during the traffic period. If it is necessary to maintain true longitudinal alignment of the guide rail during launching operations, some type of anchoring may be necessary.

Uniform-coverage traffic

55. Test results. Test results for lane 2 covering uniform-coverage traffic without a guide rail are summarized in table 3, which includes the same type data as previously discussed for table 2. As can be noted in table 3, all test items were considered failed prior to 188 coverages except item 1. The better mat performance in item 1 was the result of the increase in strength of the sand subgrade during the period of traffic. As can be noted in table 3, the CBR of the sand increased from an initial value of 7 to 32 at the end of traffic.

56. Service life. A plot of CBR versus coverages for the Kaiser AM2 tested without the guide rail is shown in plate 15. These data indicate that a subgrade CBR of about 15 is required for adequate support of the Kaiser mat to sustain 188 coverages of traffic of a 27,000-lb single-wheel load and 400-psi tire inflation pressure. In previous tests at the WES, the Harvey modified mat withstood 1[illegible]3 coverages of the same load and tire pressure on a subgrade having a CBR of 4.1 (see WES MP No. 4-747).

PART IV: CONCLUSIONS

57. The following conclusions are drawn from the data presented in this report:

- a. The guide rail used in conjunction with AM2 in this study will sustain aircraft operations without structural damage under the conditions of subgrade strength, wheel load, and load repetitions indicated in subparagraphs b, c, and d below. However, some anchoring may be necessary to maintain true longitudinal alignment of the guide rail.

- b. The Kaiser AM2 used in conjunction with the guide rail on a subgrade having a CBR of 10 will sustain approximately 90 passes of a 27,000-lb single-wheel load and 400-psi tire inflation pressure when applied in a single path at the junction of the guide rail and the mat.

- c. Harvey modified AM2 used in conjunction with the guide rail on a subgrade having a CBR of 10 will sustain about 470 passes of a 27,000-lb single-wheel load and 400-psi tire inflation pressure when applied in a single path at the junction of the guide rail and the mat (see plate 14).

- d. The Kaiser AM2 used in conjunction with the guide rail on a subgrade having a CBR of 5 or more will sustain 1600 passes of a 27,000-lb single-wheel load and 400-psi tire inflation pressure when applied in a single path approximately 7.5 ft away from the guide rail.

- e. The Kaiser AM2 used without the guide rail on a subgrade having a CBR of 15 or more will sustain 1600 cycles (188 coverages) of a 27,000-lb single-wheel load and 400-psi tire inflation pressure.

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Table 1

Summary of CBR, Water Content, and Density Data

Test Lane	Test Item	Subgrade Material	0 Coverages: Pit No.	0 Coverages: Depth in.	0 Coverages: CBR	0 Coverages: Water Content %	0 Coverages: Dry Density lb/cu ft	Failure or End of Traffic: Traffic Passes or Coverages	Failure or End of Traffic: Pit No.	Failure or End of Traffic: Depth in.	Failure or End of Traffic: CBR	Failure or End of Traffic: Water Content %	Failure or End of Traffic: Dry Density lb/cu ft
1	1	Sand	1 and 2	0	2.1	3.8	98.2	80	9	0	5	2.7	100.1
				6	4.3	3.3	97.7			6	11	2.6	111.5
				12	3.6	4.1	96.1			12	10	3.1	96.7
	2	Clay	3 and 4	0	9	22.7	99.1	100	11	0	11	22.5	99.8
				6	11	21.3	97.7			6	13	21.7	97.7
				12	11	22.1	100.8			12	14	21.4	102.7
	3	Clay	5 and 6	0	7	23.2	98.2	80	13	0	8	24.6	97.9
				6	9	23.1	99.2			6	9	22.9	100.2
				12	6	24.3	97.3			12	8	24.8	98.0
	4	Clay	7 and 8	0	4.8	26.6	94.1	20	15	0	4	26.9	93.3
				6	4.7	24.1	96.6			6	7	24.2	96.9
				12	4.9	25.3	95.4			12	5	25.9	96.5
2	1	Sand	1 and 2	0	2.1	3.8	--	1600	10	0	27	2.7	103.7
				6	4.3	3.3	--			6	23	3.1	107.1
				12	3.6	4.1	--			12	22	4.3	100.3
	2	Clay	3 and 4	0	9	22.7	99.1	1600	12	0	17	21.4	101.4
				6	11	21.3	97.7			6	12	21.8	101.1
				12	11	22.1	100.8			12	9	22.4	99.5
	3	Clay	5 and 6	0	7	23.2	98.2	1600	14	0	14	22.8	101.6
				6	9	23.1	99.2			6	7	23.7	99.8
				12	6	24.3	97.3			12	7	23.7	99.4
	4	Clay	7 and 8	0	4.8	26.6	94.1	1600	16	0	8	25.3	97.5
				6	4.7	24.1	96.6			6	6	24.8	96.1
				12	4.9	25.3	95.4			12	3	27.9	93.3
1-a	1	Sand	9	0	5	2.7	100.1	800	17	0	7	2.1	106.1
				6	11	2.6	111.5			6	11	2.6	111.5
				12	10	3.1	96.7			12	10	3.1	96.7
	2	Clay	11	0	11	22.5	99.8	800	18	0	19	22.7	101.6
				6	13	21.7	97.7			6	13	21.7	97.7
				12	14	21.4	102.7			12	14	21.4	102.7
	3	Clay	13	0	8	24.6	97.9	350	19	0	7	23.9	100.4
				6	9	22.9	100.2			6	9	22.9	100.2
				12	8	24.8	98.0			12	8	24.8	98.0
	4	Clay	15	0	4.2	26.9	93.3	200	20	0	5	25.1	97.8
				6	4.7	24.2	96.9			6	7	24.2	96.9
				12	5.0	25.9	96.5			12	5	25.9	96.5
3	1	Sand	9	0	5	2.7	100.1	188	21 and 22	0	31	2.3	110.0
				6	11	2.6	111.5			6	37	3.3	108.1
				12	10	3.1	96.7			12	27	3.1	103.0
	2	Clay	11	0	11	22.5	99.0	188	23 and 24	0	13	22.6	99.9
				6	13	21.7	97.7			6	11	22.0	100.6
				12	14	21.4	102.7			12	12	22.8	99.3
	3	Clay	13	0	8	24.6	97.9	70	25 and 26	0	9	23.7	99.1
				6	9	22.9	100.2			6	9	24.3	97.0
				12	8	24.8	98.0			12	8	24.9	97.9
	4	Clay	15	0	4.2	26.9	93.3	40	27 and 28	0	5	23.0	95.0
				6	7	24.2	96.9			6	5	24.7	98.4
				12	5	25.9	96.5			12	4.1	26.2	93.1

Table 2

Summary of Traffic Test Results

27,000-lb Single-Wheel Load, 400-psi Tire Pressure

Traffic Applied in Single Path

Test Lane	Test Item	AM2 Mat	Sub-grade Mate-rial	Rated Sub-grade CBR	No. Planks Subjected to Traffic	Traffic Passes	Mat Breakage: End-Joint Weld Cracks	Mat Breakage: End-Joint Failures	Mat Breakage: Indi-cated Core Failures	No. Planks Failed	Maximum Mat Deflec-tion in.	Rating of Item
1	1	Kaiser	Sand	3 to	15	0	--	--	--	--	0.5	
		2-ft		10		20	0	--	0	--	0.9	
		by				40	5	0	0	--	--	
		12-ft				80	15	6	0	6	1.3	Failed
	2	Kaiser	Clay	11	20	0	--	--	--	--	0.7	
		2-ft				20	1	0	0	--	0.7	
		by				40	10	1	0	1	--	
		12-ft				80	12	3	0	3	--	
						100	16	8	0	8	0.8	Failed
	3	Kaiser	Clay	8	20	0	--	--	--	--	0.7	
		2-ft				20	2	0	0	0	0.7	
		by				70	10	4	0	4	--	Failed at 70 Passes
		12-ft				80	13	8	0	8	0.9	
	4	Kaiser	Clay	5	20	0	--	--	--	--	0.8	
		2-ft				20	14	4	0	4	1.1	Failed
		by										
		12-ft										
2	1	Kaiser	Sand	3 to	15	0	--	--	--	--	0.6	
		2-ft		24		1000	0	0	0	0	1.3	
		by				1600	0	0	8	0	1.1	Satisfactory
		12-ft										
	2	Kaiser	Clay	11	20	0	--	--	--	--	0.4	
		2-ft				1000	0	0	0	0	0.5	
		by				1600	1	0	0	0	0.5	Satisfactory
		12-ft										
	3	Kaiser	Clay	8	20	0	--	--	--	--	0.3	
		2-ft				1000	0	0	0	0	0.3	
		by				1600	1	0	1	0	0.6	Satisfactory
		12-ft										
	4	Kaiser	Clay	5	20	0	--	--	--	--	0.5	
		2-ft				1000	1	0	0	--	0.6	
		by				1600	6	2	11	2	0.9	Borderline
		12-ft										
1-a	1	Harvey	Sand	9	15	0	--	--	--	--	--	
		Modi-				200	0	0	0	0	--	
		fied				350	1	1	--	--	--	
		2-ft				800	8	5	0	5	--	Failed
		by										
		12-ft										
	2	Harvey	Clay	14	18	0	--	--	--	--	--	
		Modi-				200	0	0	0	0	--	
		fied				350	5	0	0	0	--	
		2-ft				800	11	5	0	5	--	Failed
		by										
		12-ft										
	3	Harvey	Clay	9	20	0	--	--	--	--	--	
		Modi-				200	7	1	0	1	--	
		fied				350	12	6	0	6	--	Failed
		2-ft										
		by										
		12-ft										
	4	Mat	Clay	5	18 (Total)	0	--	--	--	--	--	
		Orig-			6	100	6	6	0	6	--	Failed
		inal										
		2-ft										
		by										
		12-ft										
	4	Harvey	Clay	5	10	100	5	1	0	1	--	
		Modi-				200	9	4	0	4	--	Failed
		fied										
		2-ft										
		by										
		12-ft										
	4	Kaiser	Clay	5	2	200	0	0	0	0	--	Satisfactory
		4-ft										
		by										
		4-ft										

Table 3

Summary of Traffic Test Results

27,000-lb-Single-Wheel Load, 400-psi Tire Pressure

Uniform Coverage

Test Lane	Test Item	AM2 Mat	Subgrade Material	Rated Subgrade CBR	No. Panels Subjected to Traffic	Traffic Coverages	Mat Breakage: End Joint Weld Cracks	Mat Breakage: End Joint Failures	Mat Breakage: Indicated Core Failures	No. Panels Failed	Maximum Mat Deflection in.	Rating of Item
3	1	Kaiser 2-ft by 12-ft	Sand	7 to 32	23	0	--	--	--	--	0.3	
						20	0	0	0	0	0.3	
						40	0	0	0	0	0.3	
						70	0	0	0	0	0.7	
						188	0	0	0	0	1.0	Satisfactory
3	2	Kaiser 2-ft by 12-ft	Clay	12	30	0	--	--	--	--	0.5	
						20	0	0	0	0	0.5	
						40	3	0	0	0	0.4	
						70	5	0	0	0	--	
						100	6	1	0	1	0.4	Failed at about 150 coverages
						188	12	9	0	9	0.6	
3	3	Kaiser 2-ft by 12-ft	Clay	8	30	0	--	--	--	--	0.7	
						20	0	0	0	0	0.7	
						40	3	0	0	0	0.7	
						70	15	7	0	7	0.6	Failed
3	4	Kaiser 2-ft by 12-ft	Clay	5	30	0	--	--	--	--	0.5	
						20	8	1	0	1	0.4	
						30	10	4	0	4	--	
						40	17	8	0	8	0.9	Failed

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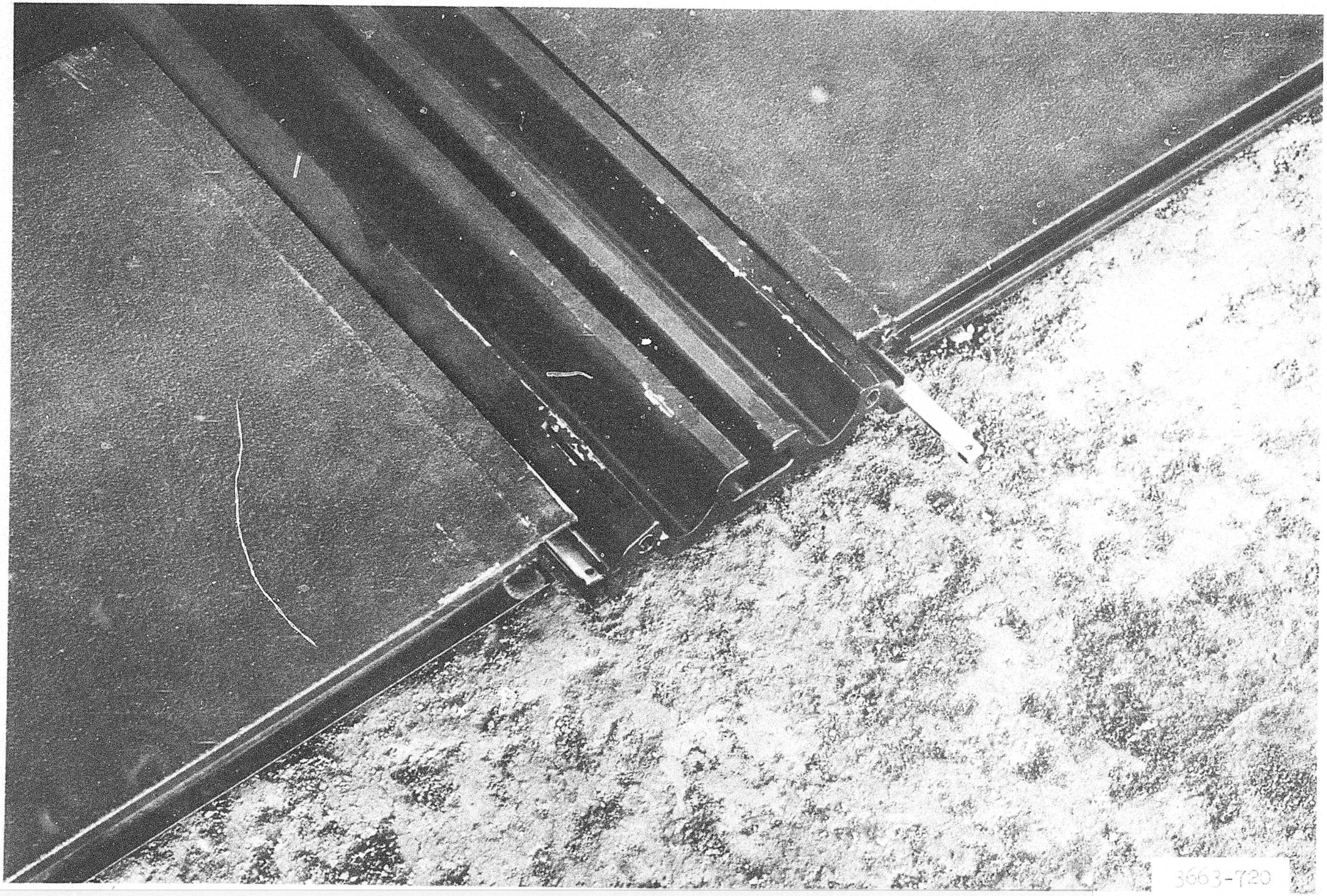
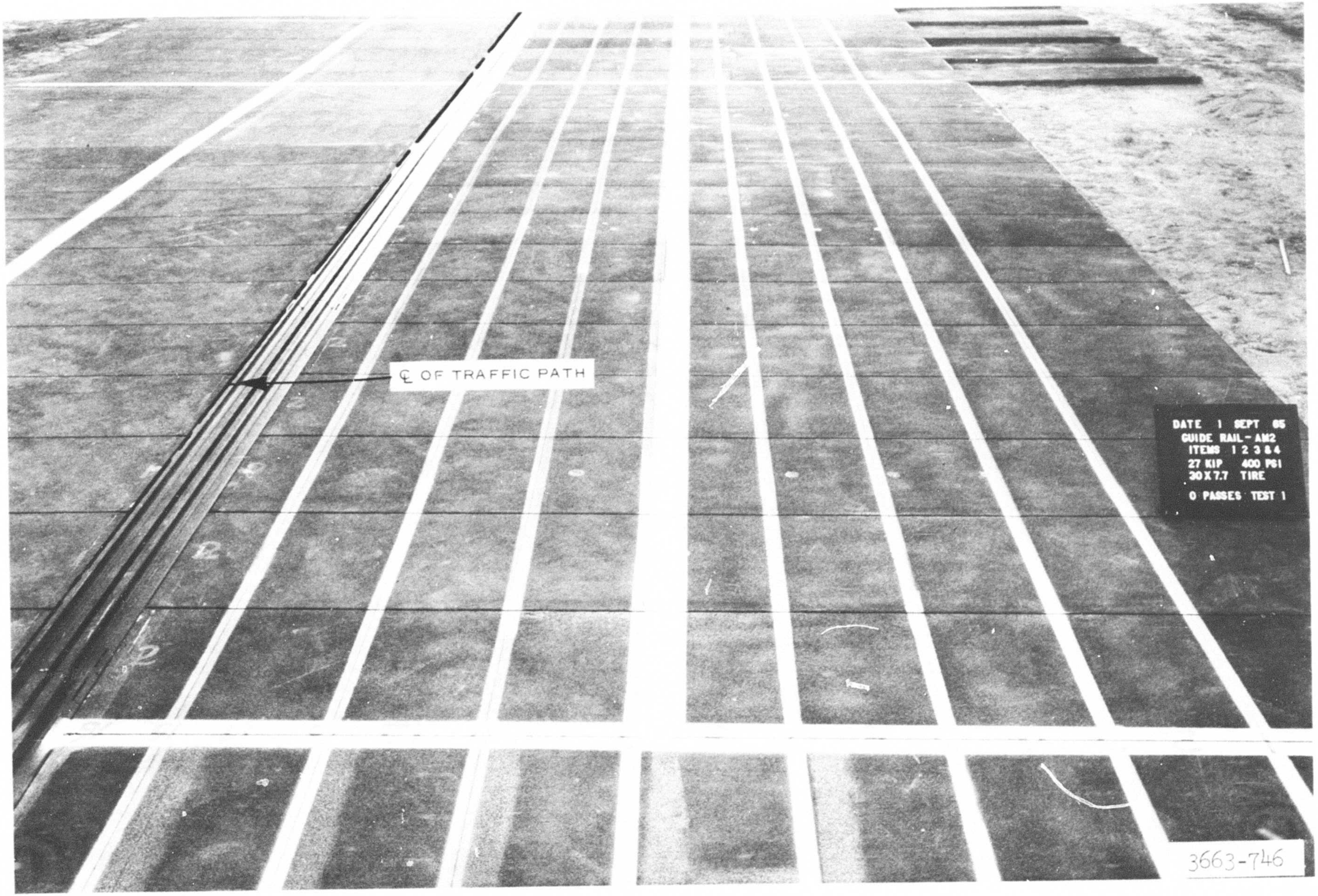


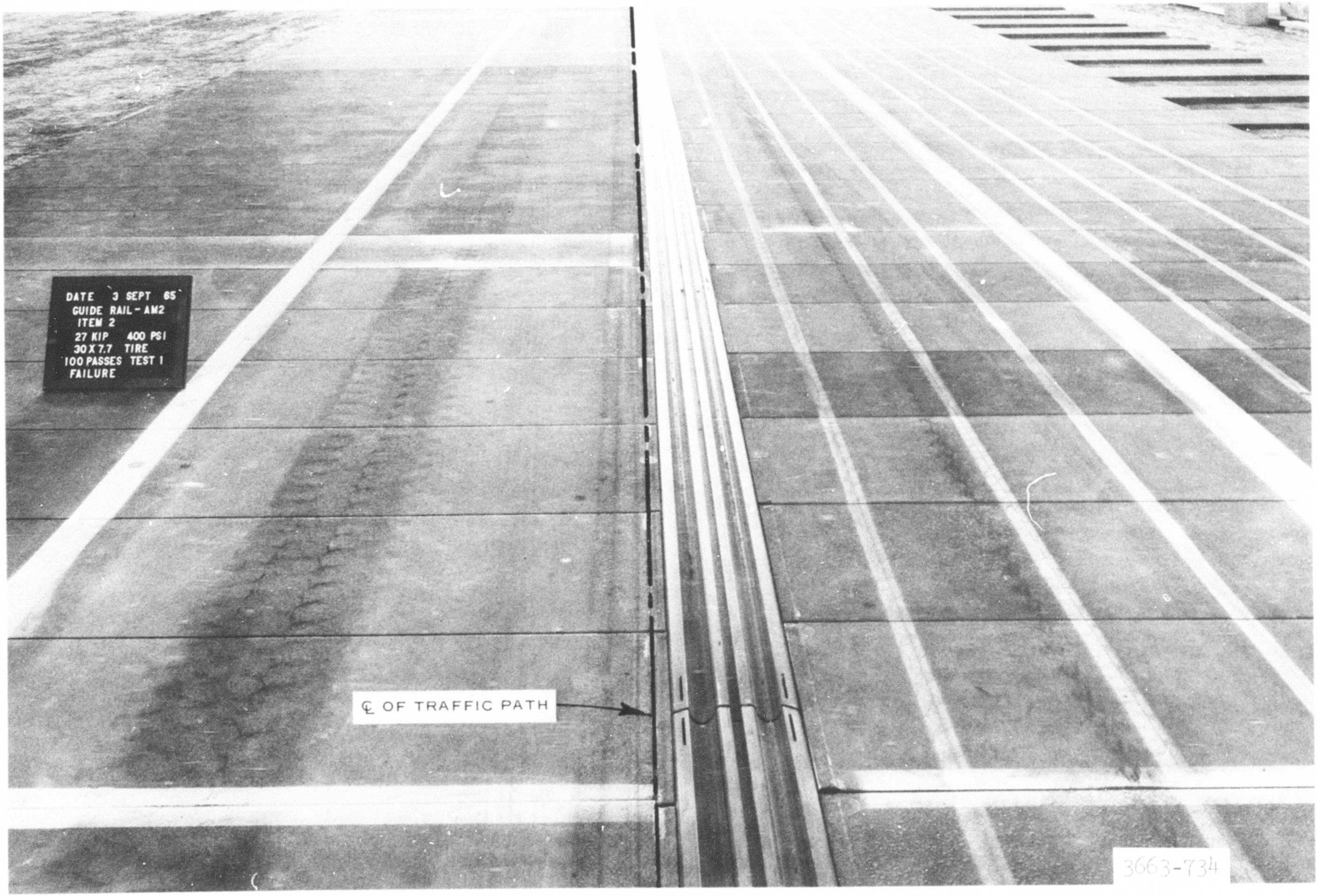
Photograph 1. AM2 planks in place on each side of guide rail



Photograph 2. Test section with guide rail

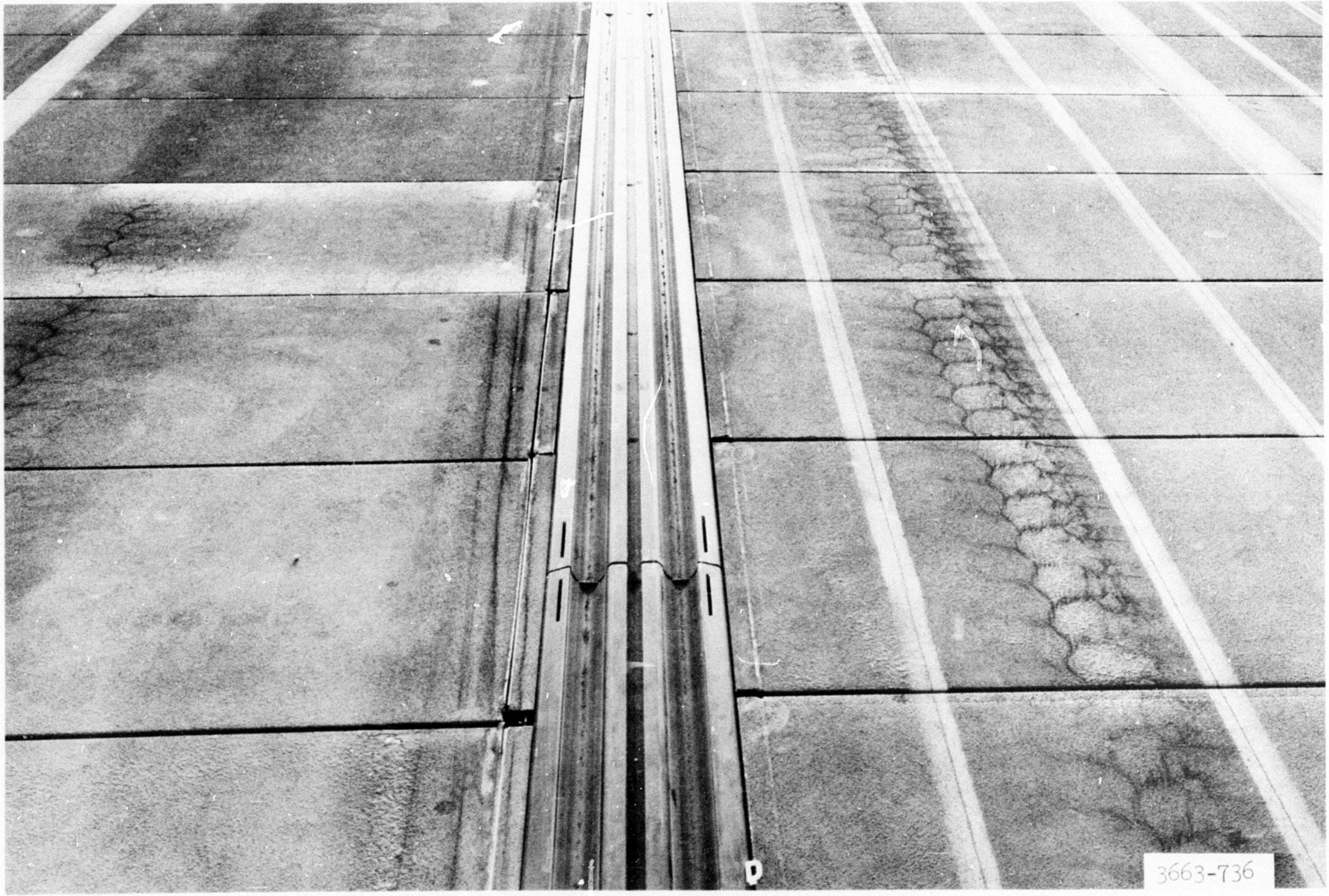
Photograph 3. Test item 4, lane 1, after 20 passes of load wheel

Photograph 4. Test item 1, lane 1, after 100 passes of load wheel



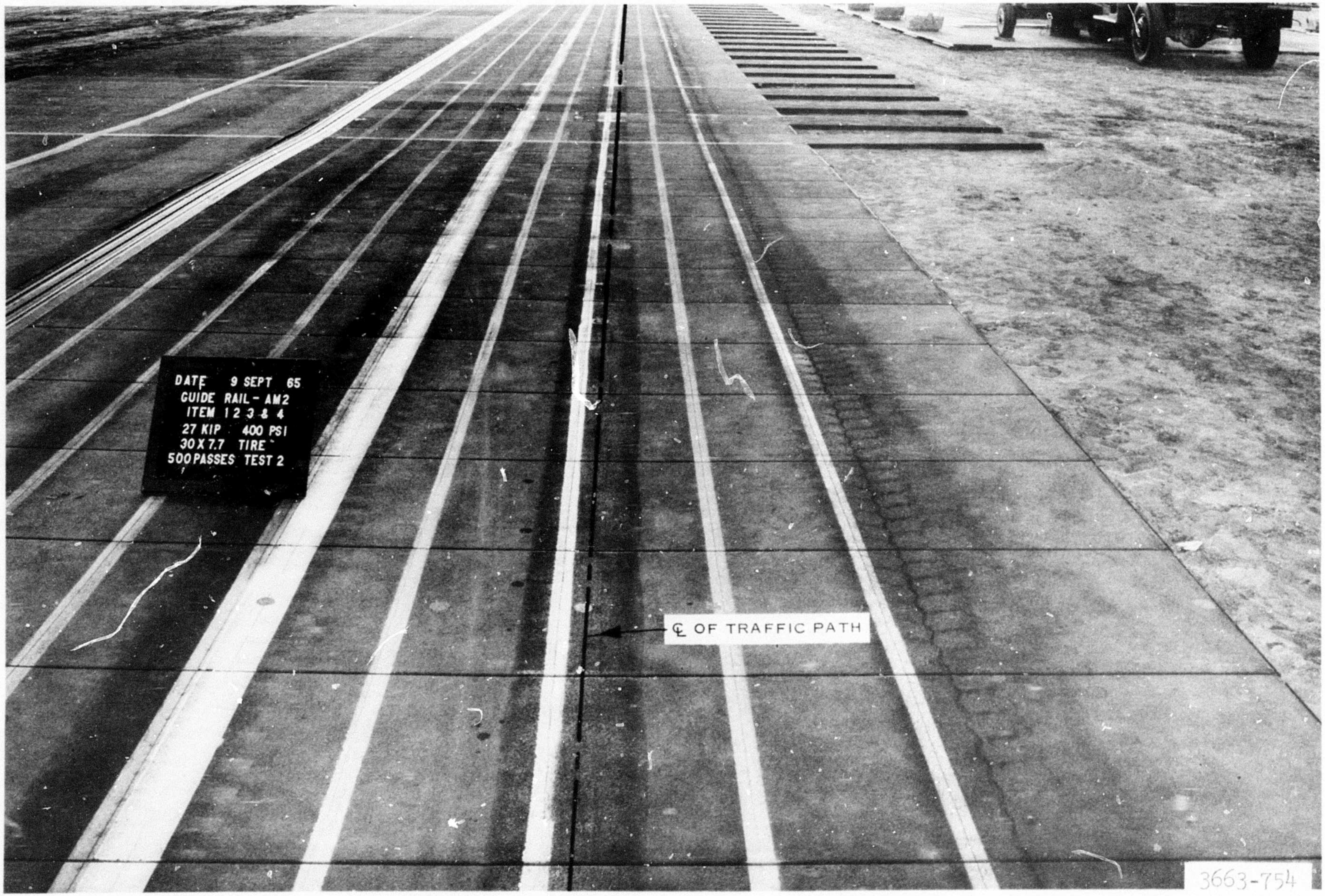
Photograph 5. Test item 2, lane 1, after 100 passes of load wheel

Photograph 6. Test item 3, lane 1, after 80 passes of load wheel



Photograph 7. Close-up of end-joint failures, lane 1, item 3

Photograph 8. Kaiser 4- by 4-ft aluminum honeycomb mat and Harvey modified AM2 in item 4, lane 1, after 100 passes



Photograph 9. Test lane 2 after 500 passes of load wheel, looking south with item 1 in foreground

Photograph 10. Test lane 2 after 1000 passes of load wheel, looking south with item 1 in foreground

Photograph 11. Dish in mat plank indicating core failure

Photograph 12. Test lane 2 after 1600 passes of load wheel

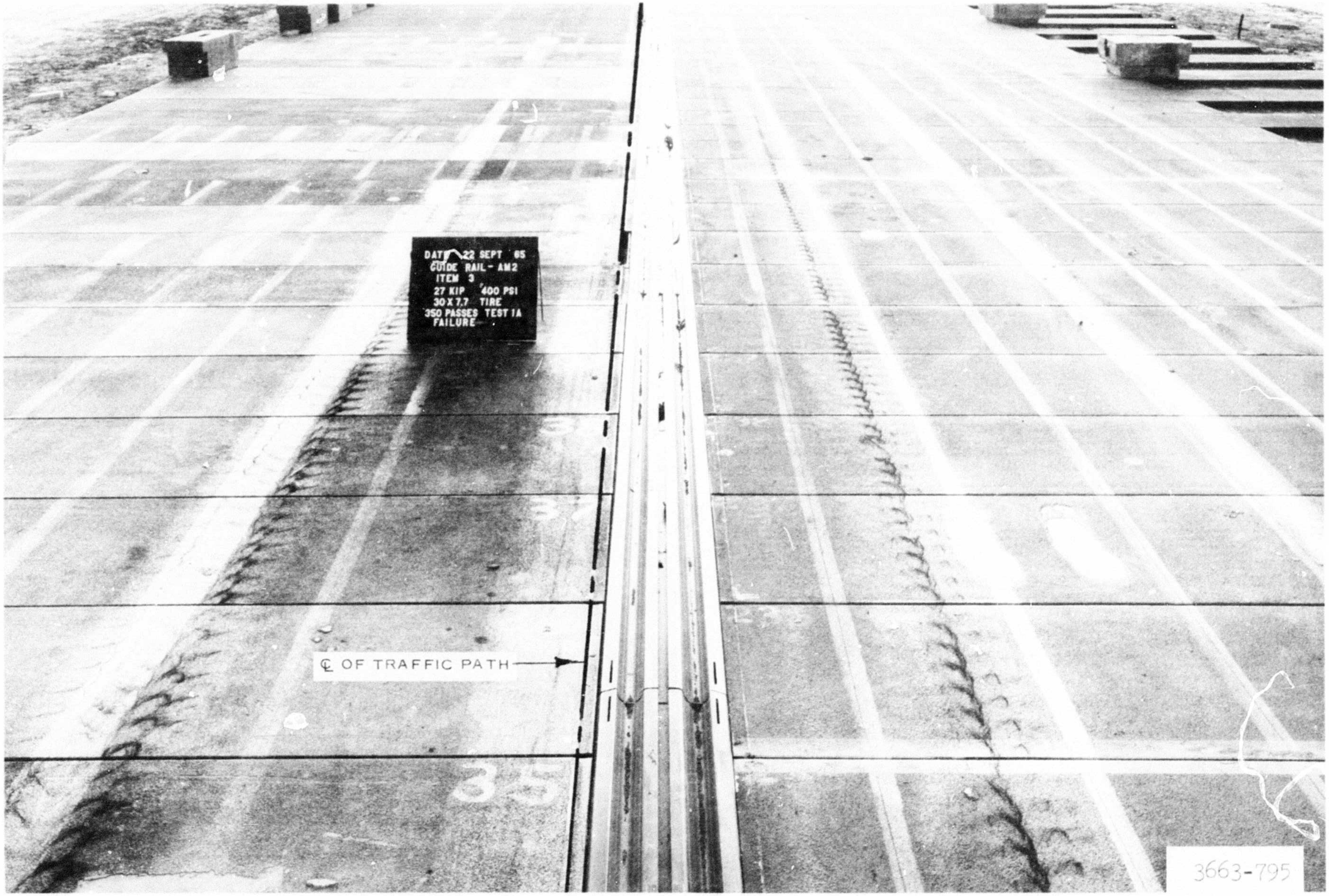
Photograph 13. Close-up of mat in item 4, lane 2, after 1600 passes of load wheel

Photograph 14. Bridging of mat over rut in subgrade

Photograph 15. Test lane 1-a prior to traffic; Harvey AM2 on left (west) side of guide rail

Photograph 16. End-joint failures in test item 4

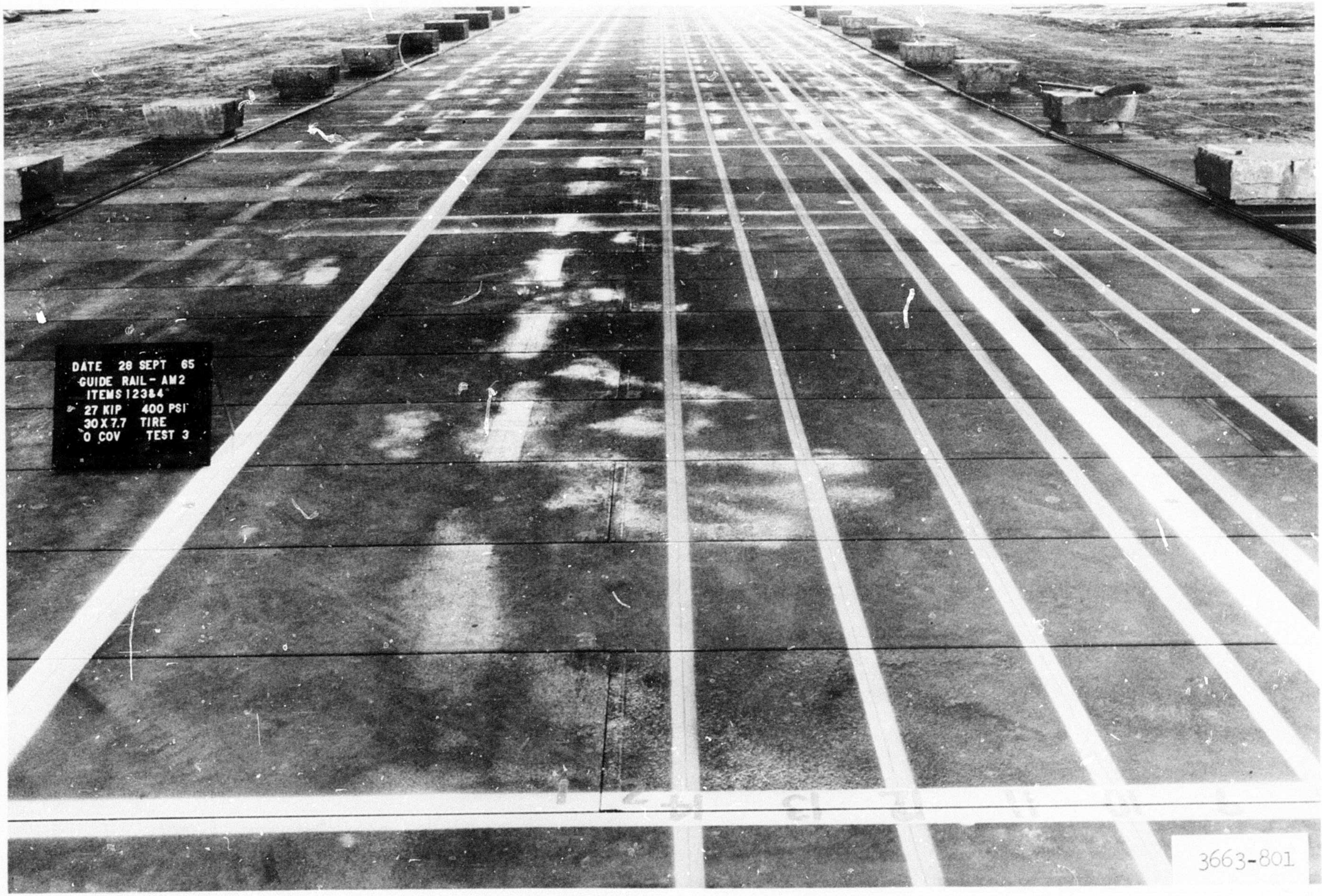
Photograph 16. End-joint failures in test item 4



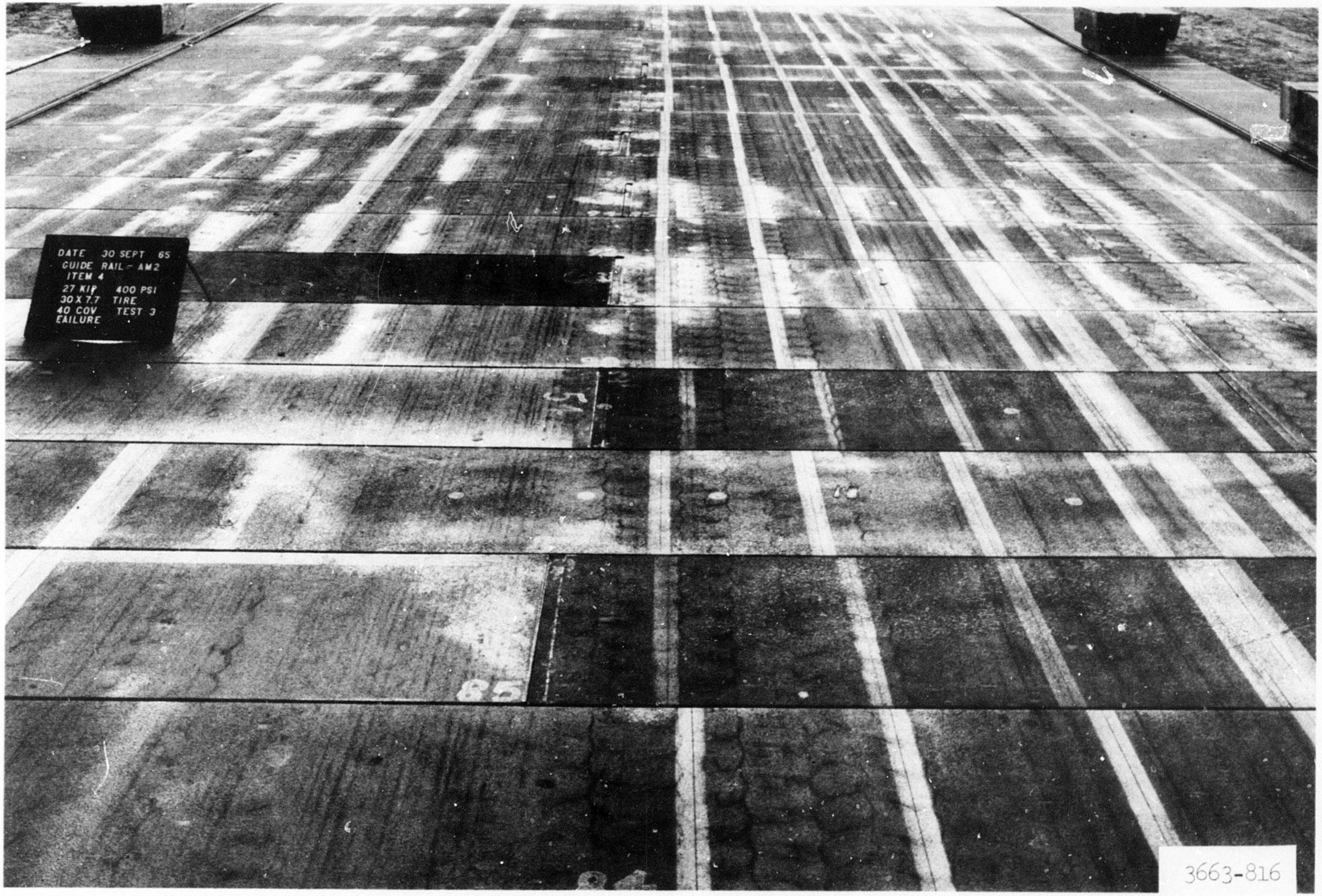
Photograph 18. Test item 3, lane 1-a, after 350 passes of load wheel

Photograph 19. Test item 1, lane 1-a, after 800 passes of load wheel

Photograph 20. Test item 2, lane 1-a, after 800 passes of load wheel



Photograph 21. Test lane 3 (Kaiser AM2 without guide rail) prior to traffic



Photograph 22. Item 4, lane 3, after 40 coverages of load wheel

Photograph 23. Item 3, lane 3, after 70 coverages of load wheel

Photograph 24. Items 1 and 2, lane 3, after 188 coverages

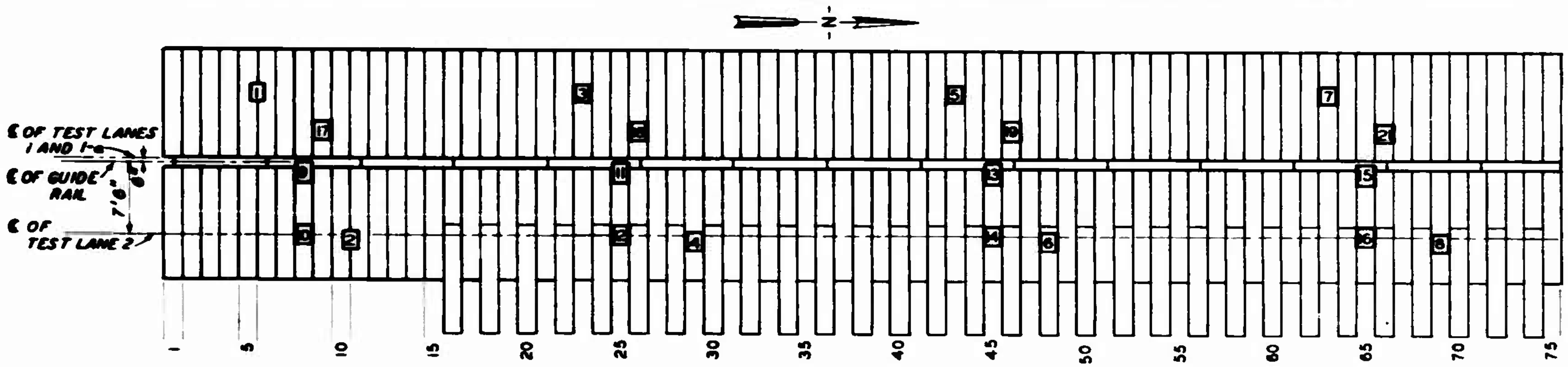


FIG.1. PLAN TEST LANES 1, 2 AND 1-a

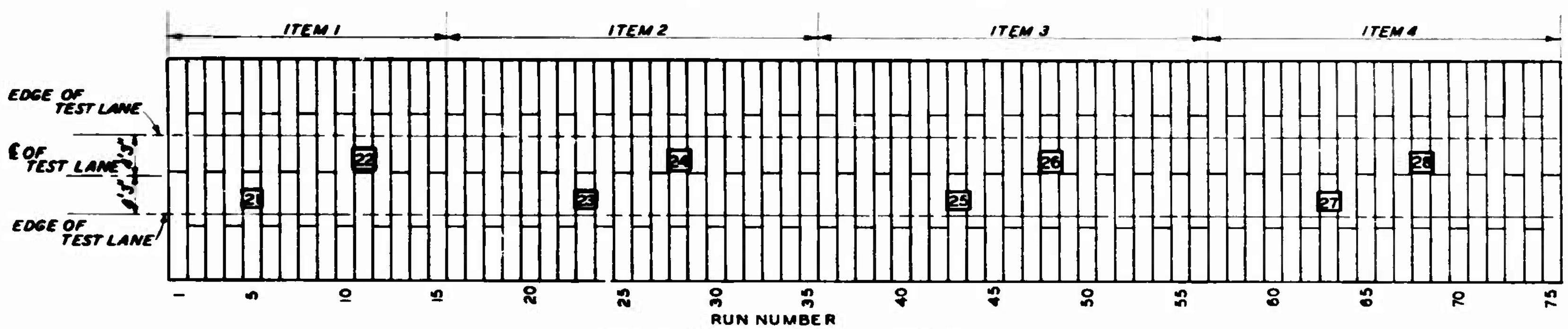


FIG.2. PLAN TEST LANE 3

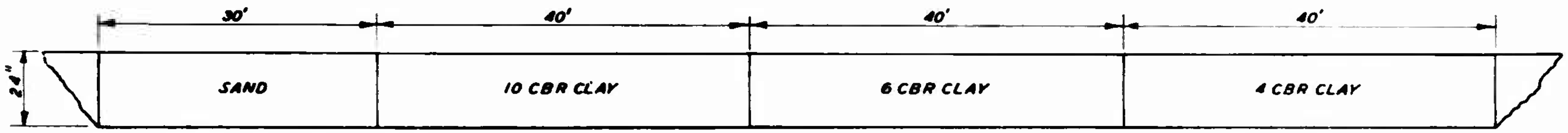


FIG.3. PROFILE

NOTE SQUARES WITH NUMBERS IN PLAN VIEWS INDICATE LOCATIONS AND NUMBERS OF CBR TEST PITS

TEST SECTION LAYOUT PLANS AND PROFILE

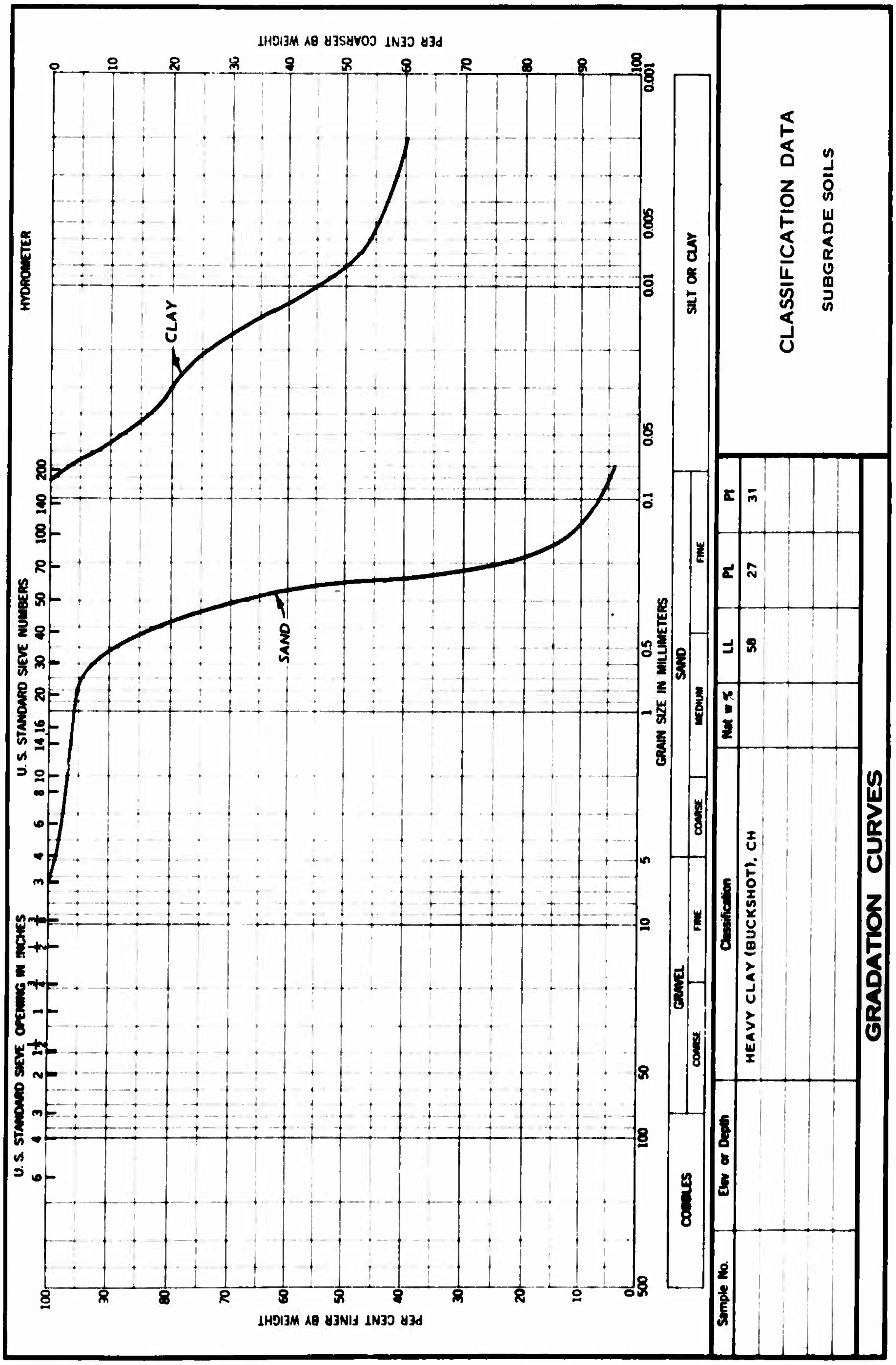
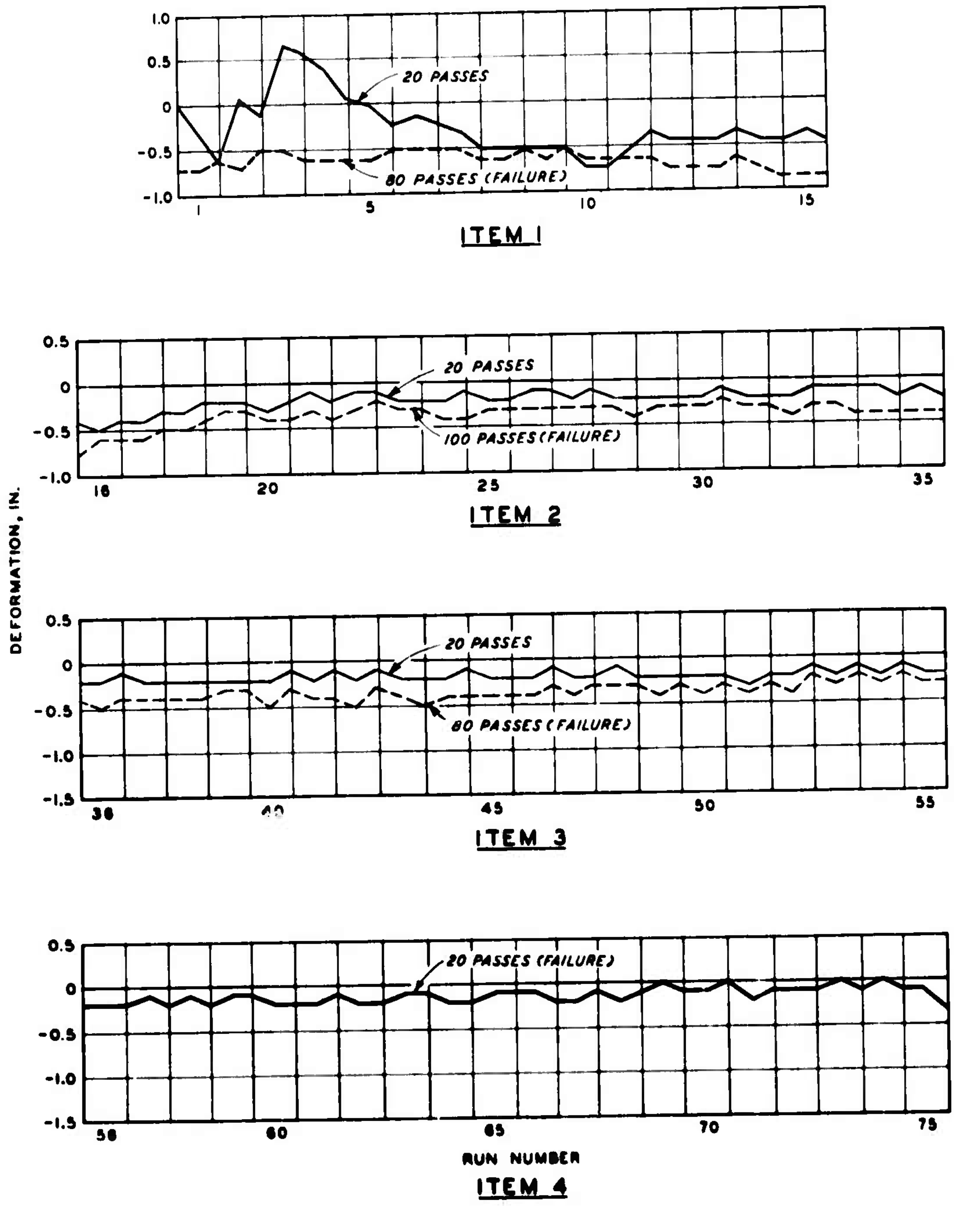

CLASSIFICATION DATA
SUBGRADE SOILS
GRADATION CURVES
U.S. STANDARD SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT FINER BY WEIGHT
PER CENT COARSER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
CLAY
SAND
COBBLES
GRAVEL
COARSE
FINE
MEDIUM
SILT OR CLAY
Sample No.
Elev or Depth
Classification
Nat w %
LL
PL
PI
HEAVY CLAY (BUCKSHOT), CH
58
27
31

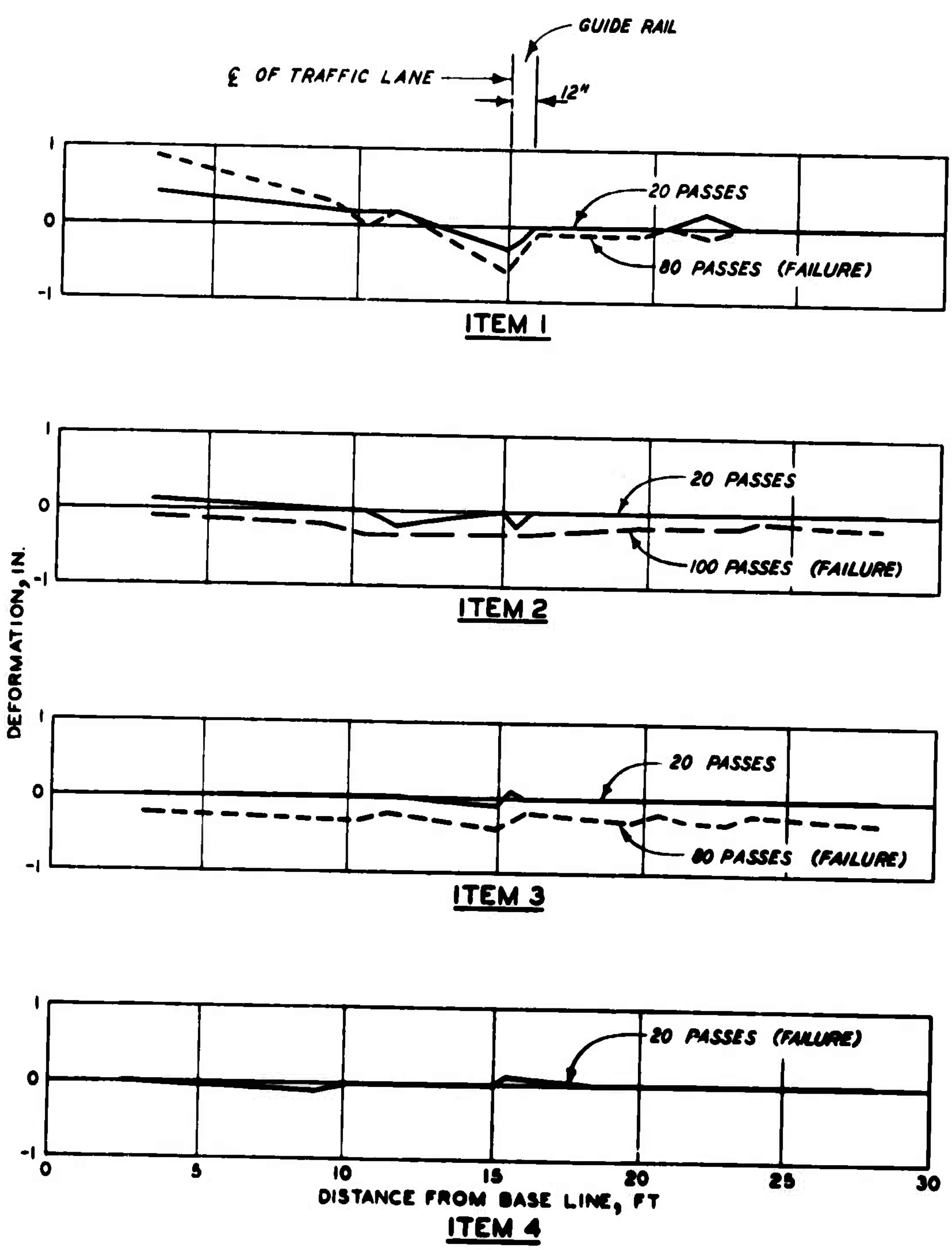
PLATE 2



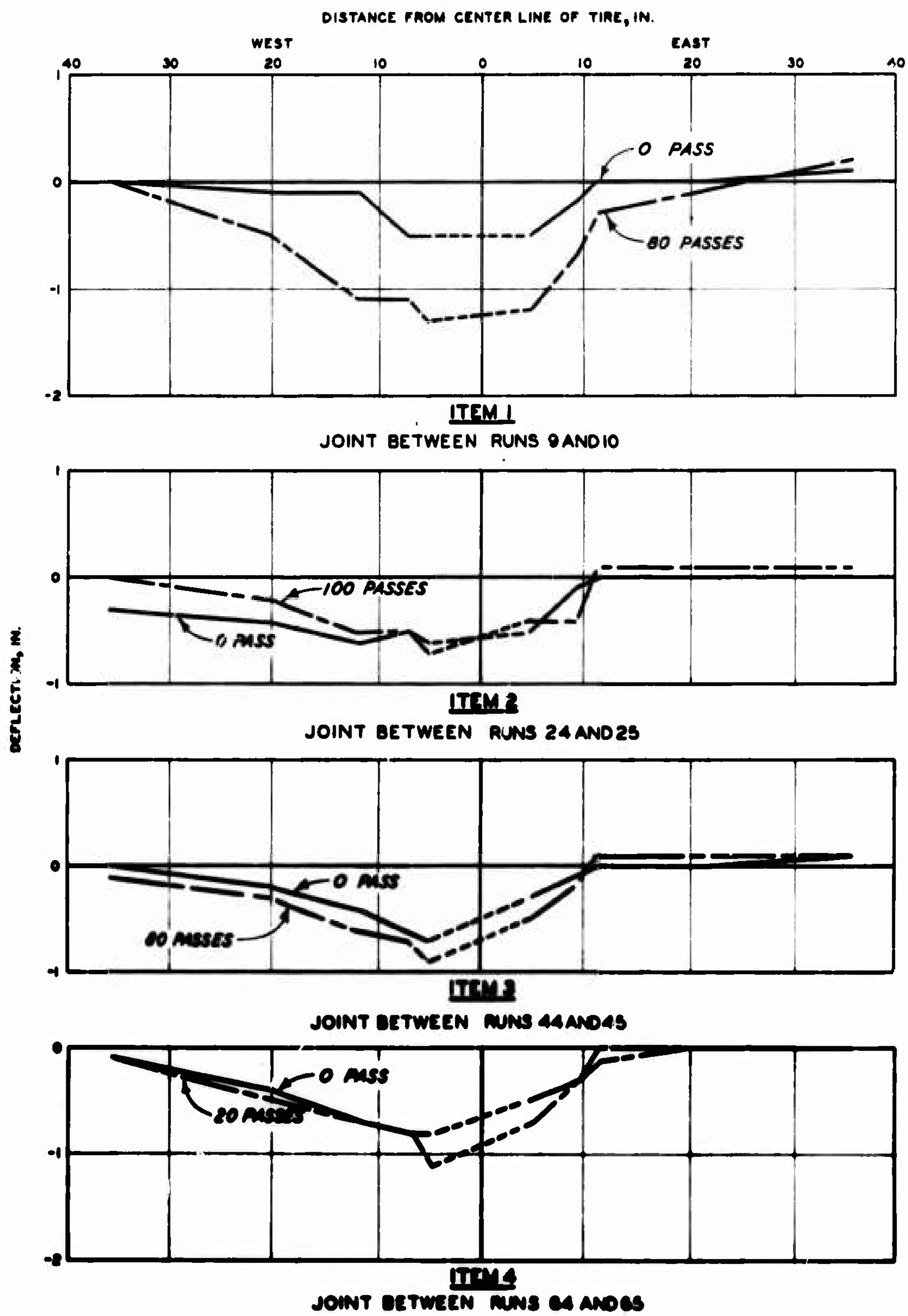
NOTE: WIDTH OF ONE RUN WAS 2 FT.

PROFILES ALONG CENTER LINE OF TRAFFIC LANE

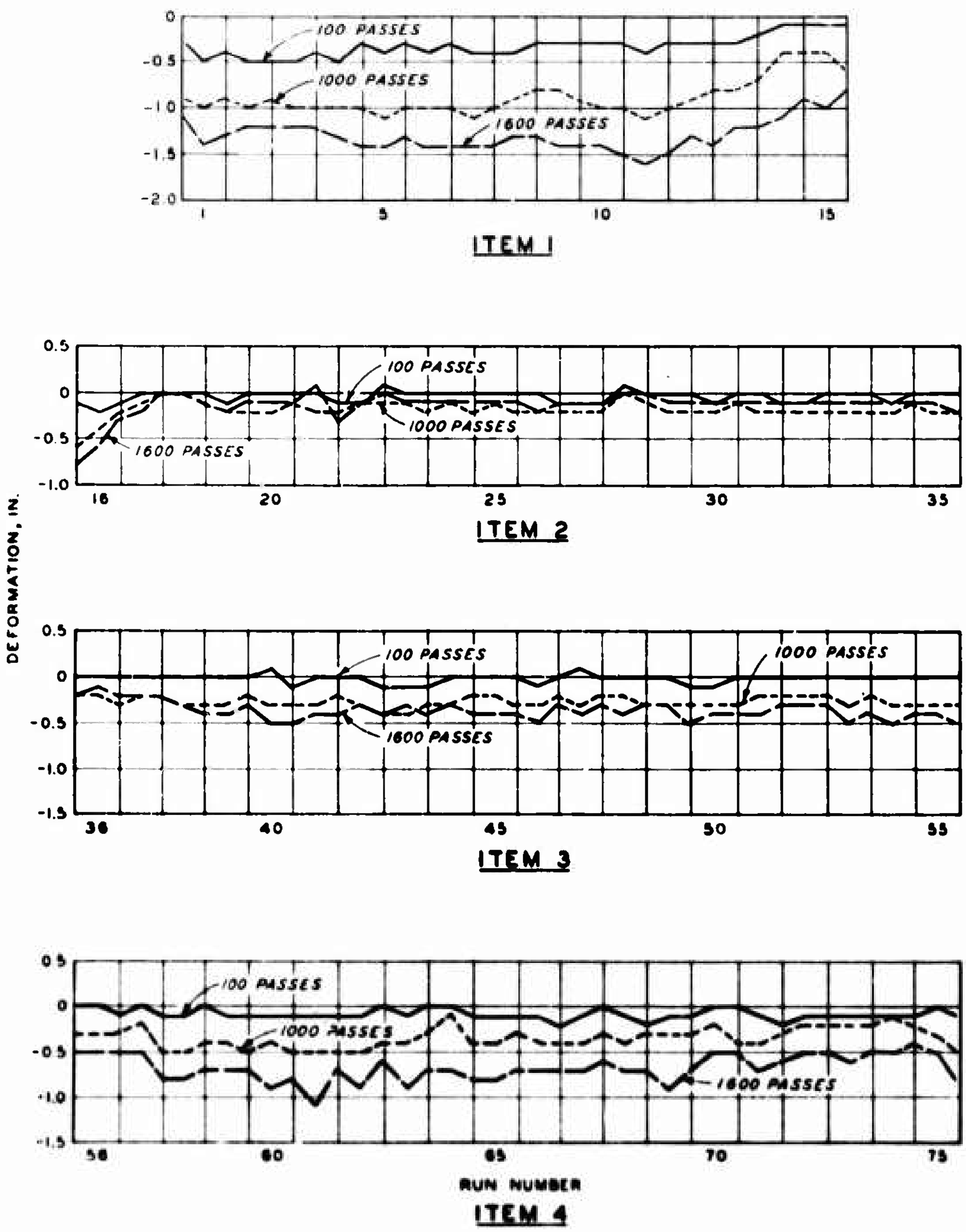
TEST LANE 1



PERMANENT MAT DEFORMATION
TEST LANE 1



ELASTIC DEFLECTION OF MAT
TEST LANE I

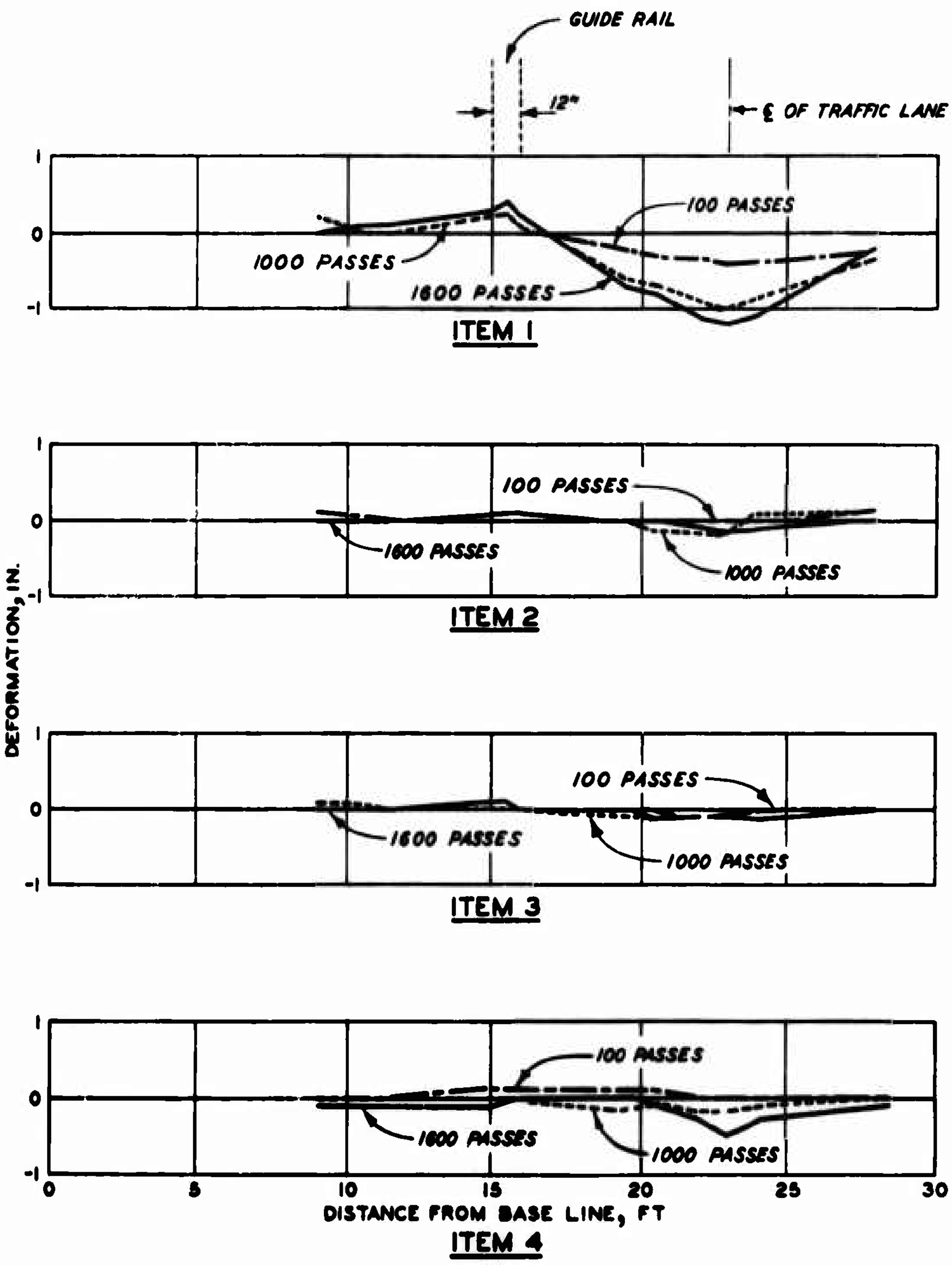


NOTE WIDTH OF ONE RUN WAS 2 FT

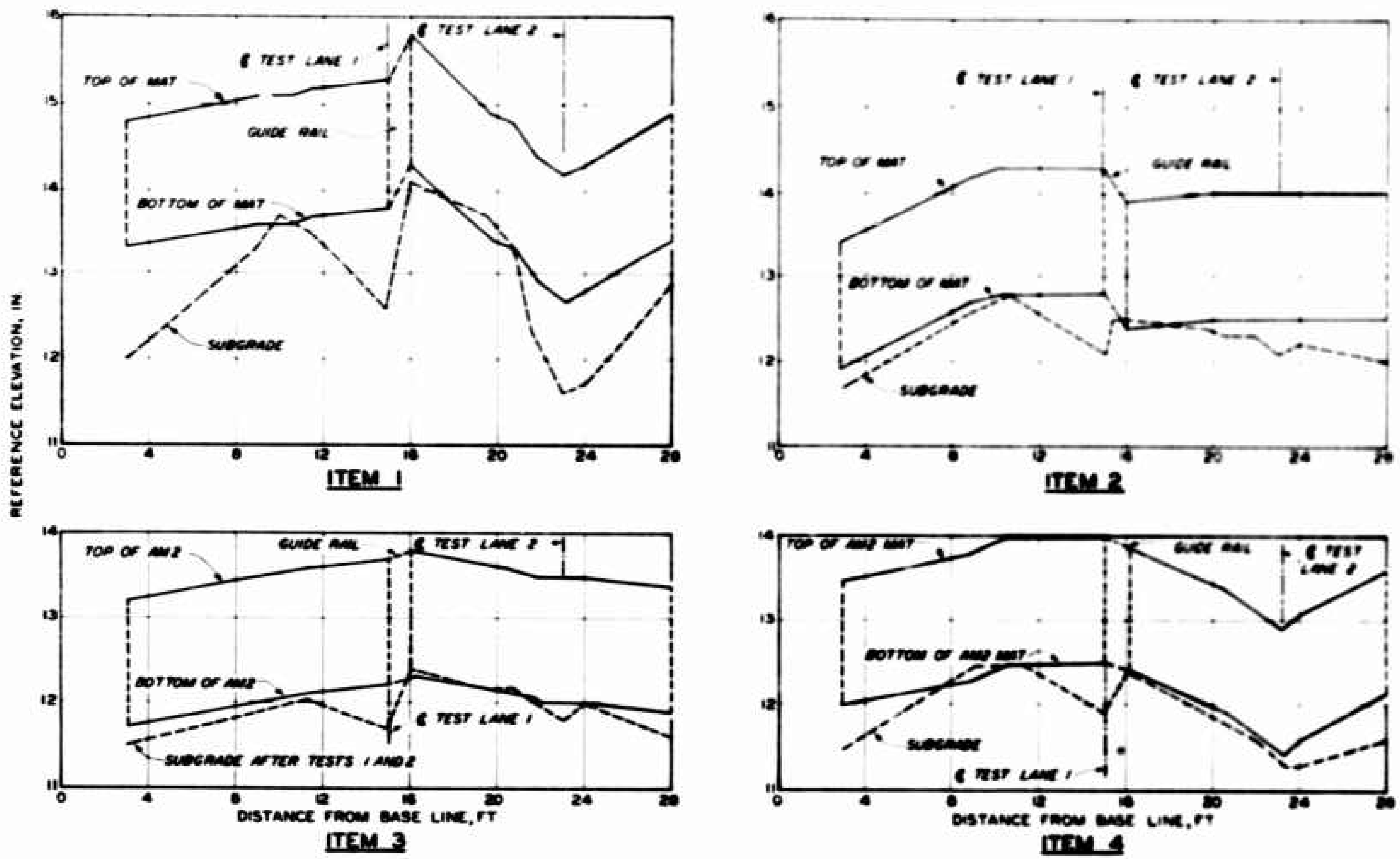
PROFILES ALONG CENTER LINE OF TRAFFIC LANE

TEST LANE 2

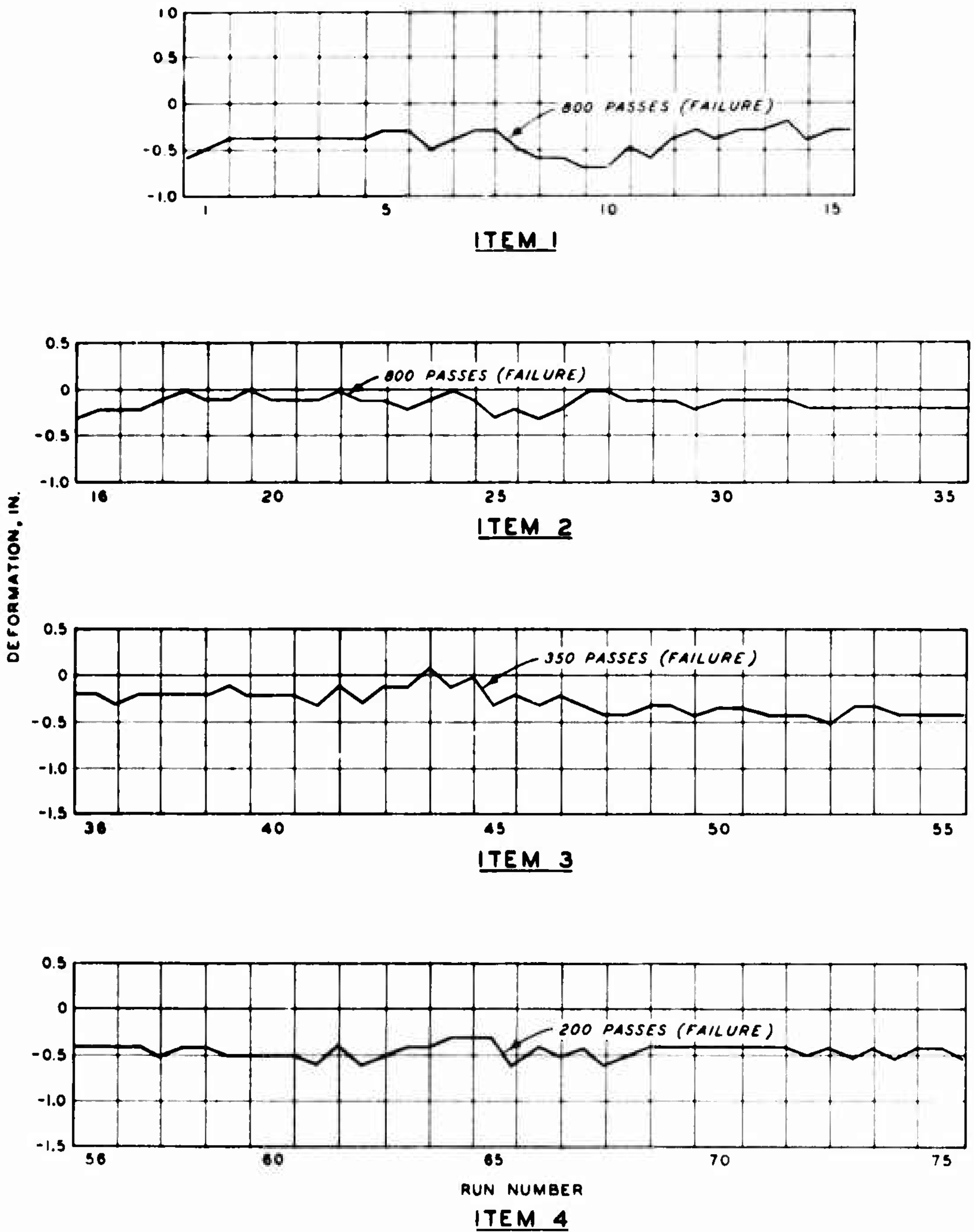
PLATE 6



PERMANENT MAT DEFORMATION
TEST LANE 2



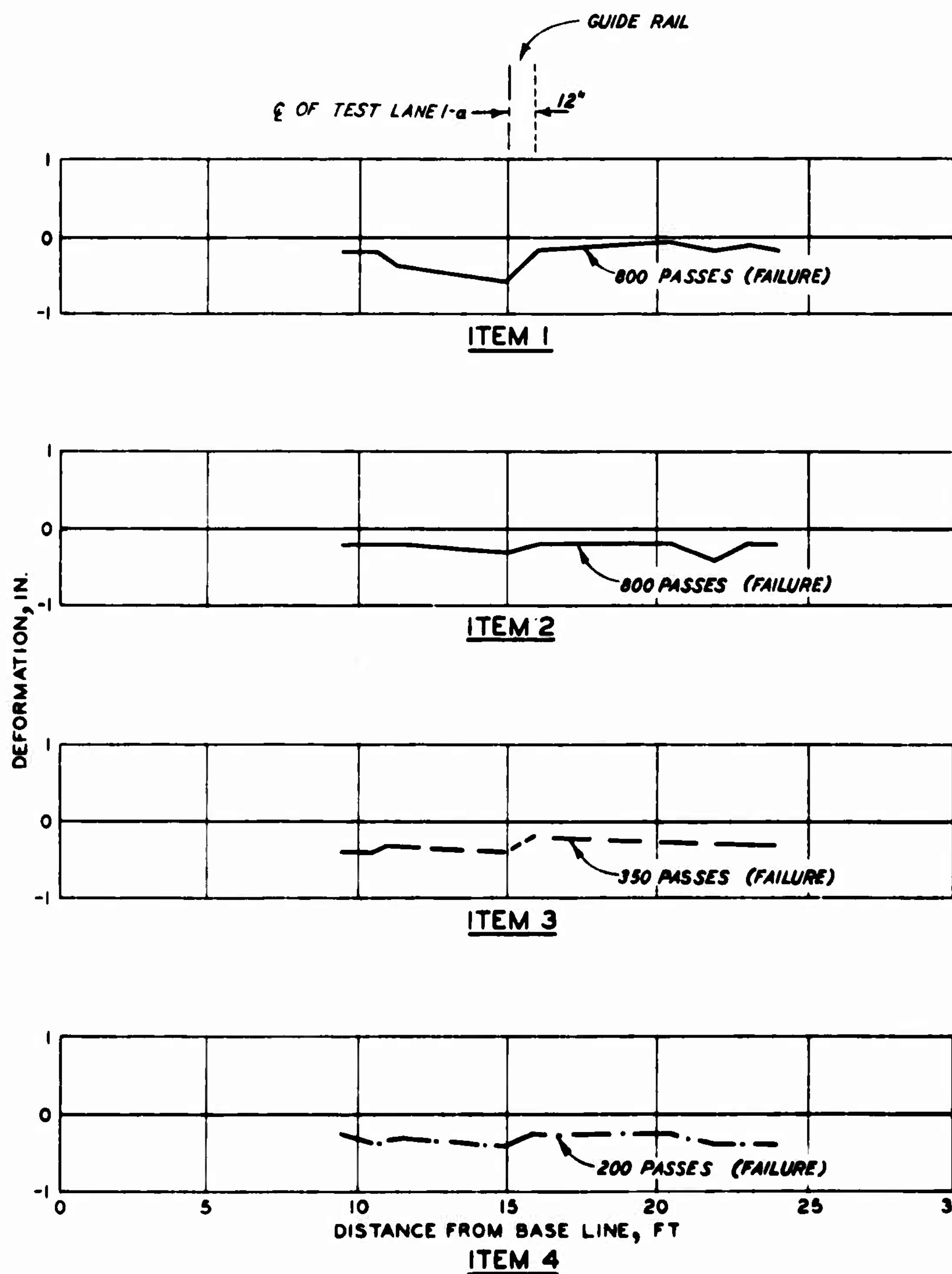
CROSS SECTIONS AT END OF TRAFFIC TEST LANES 1 AND 2



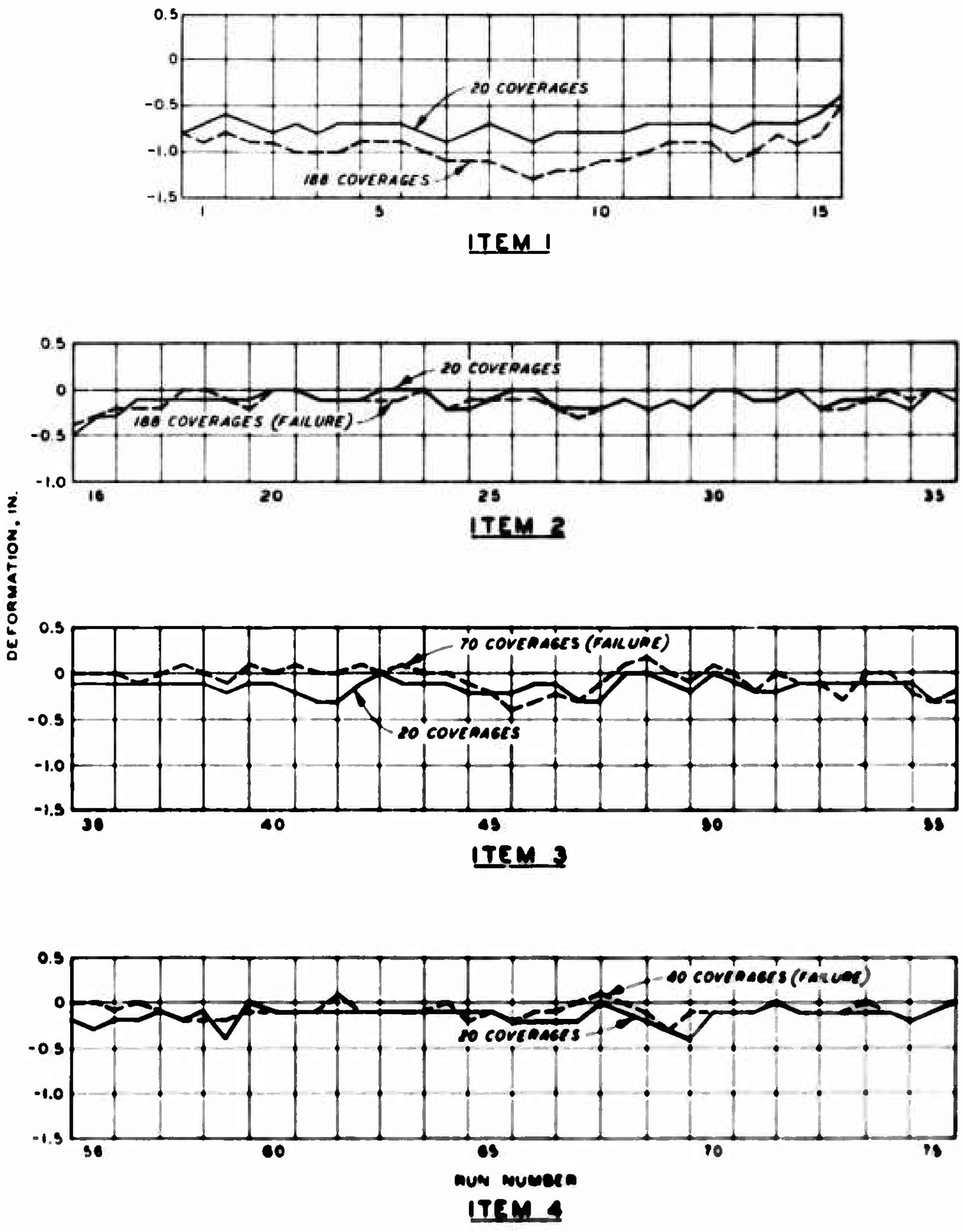
NOTE. WIDTH OF ONE RUN WAS 2 FT.

PROFILES ALONG CENTER LINE OF TRAFFIC LANE

TEST LANE I-a



PERMANENT MAT DEFORMATION
TEST LANE I-a

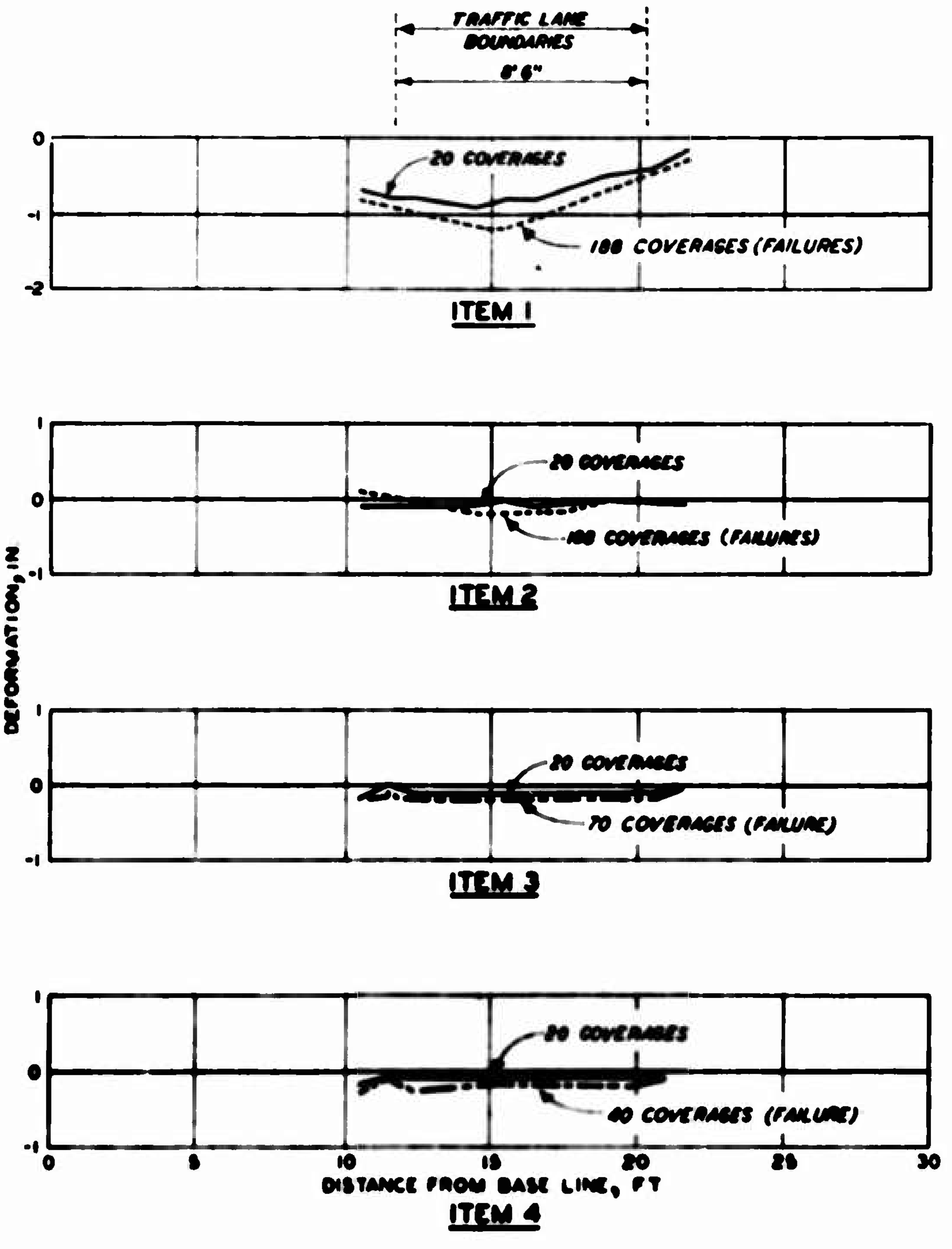


NOTE: WIDTH OF ONE RUN WAS 2 FT

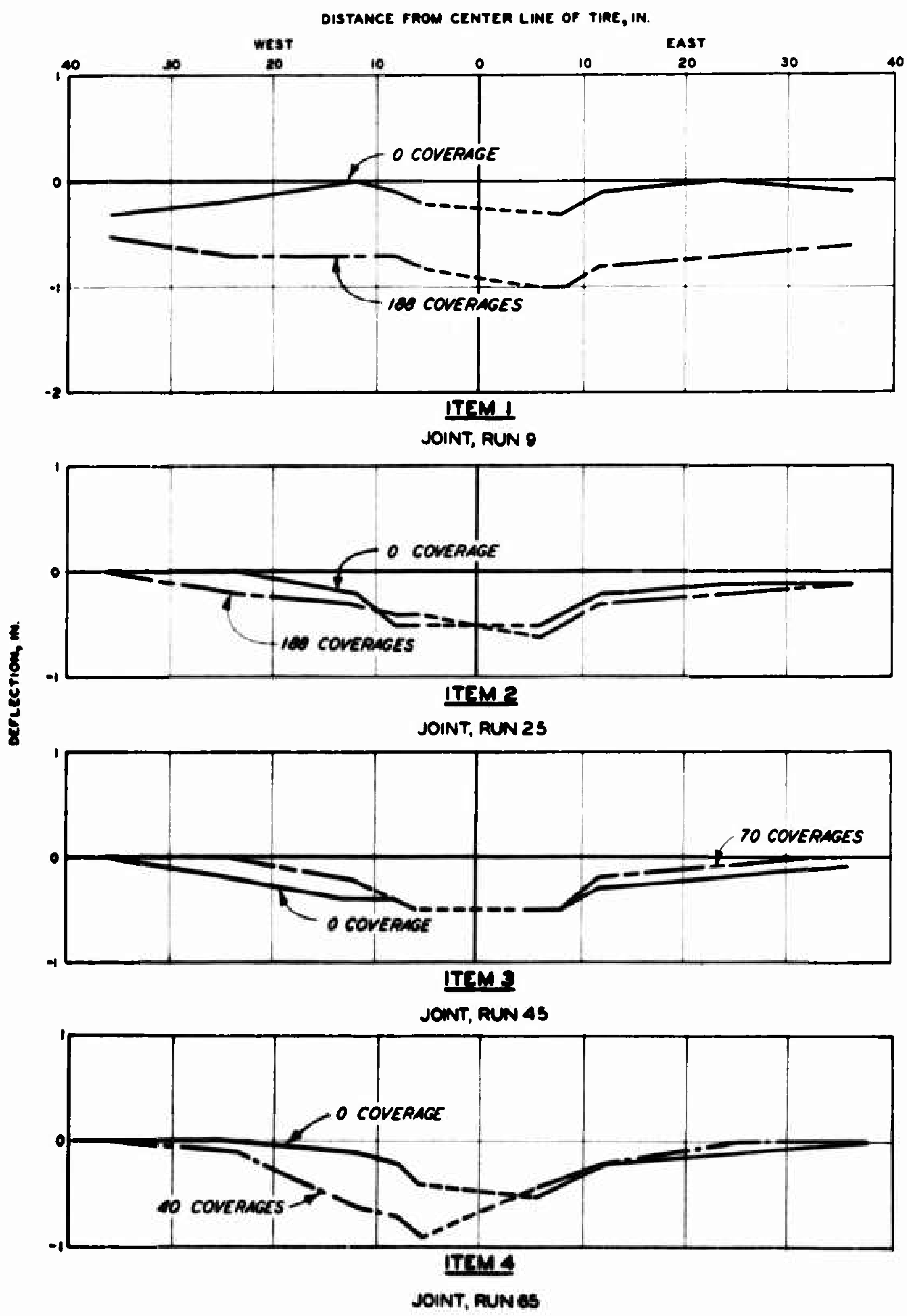
PROFILES ALONG CENTER LINE OF TRAFFIC LANE

TEST LANE 3

PLATE 11

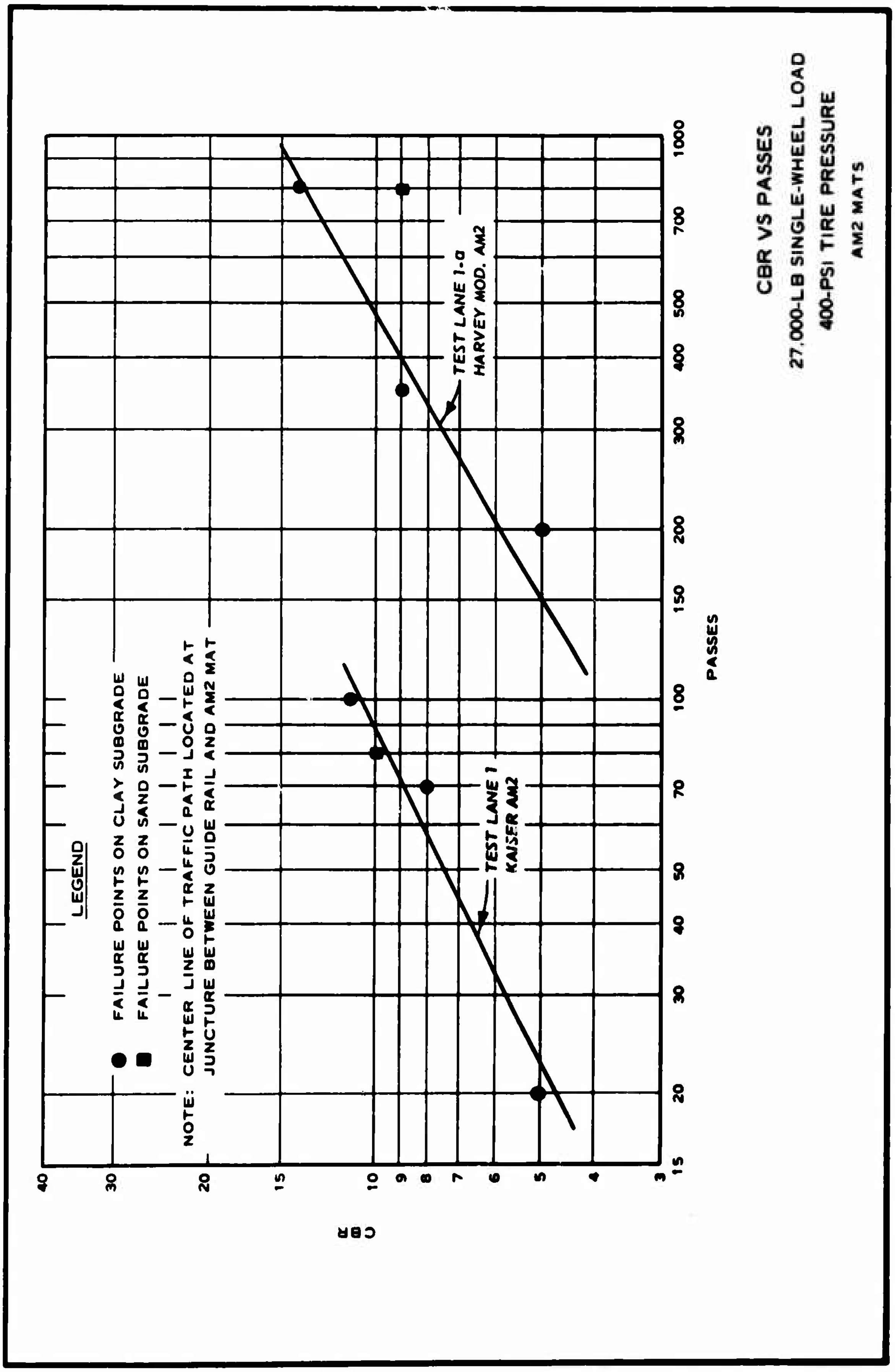


PERMANENT MAT DEFORMATION
TEST LANE 3



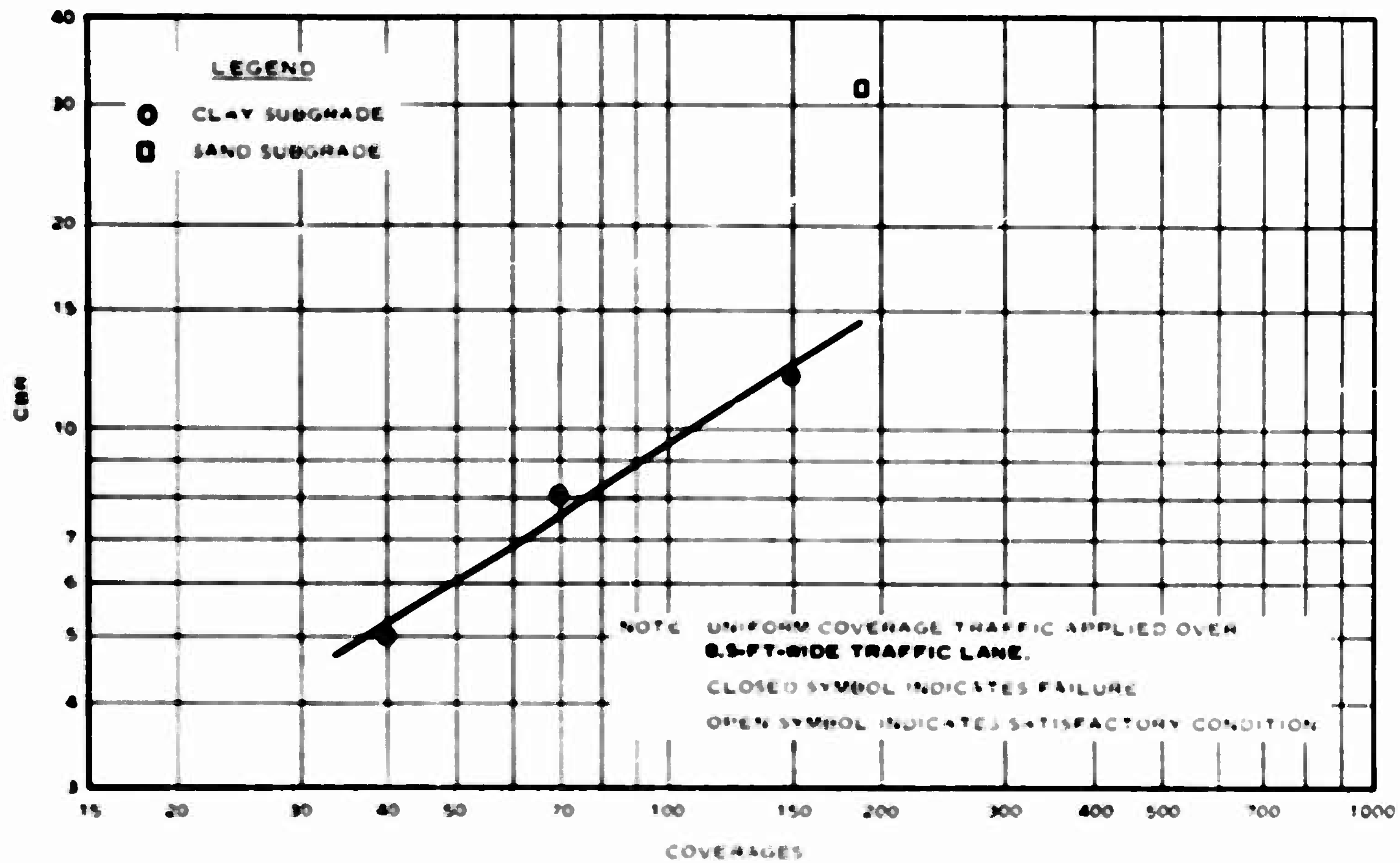
ELASTIC DEFLECTION OF MAT

TEST LANE 3



CBR VS PASSES
27,000-LB SINGLE-WHEEL LOAD
400-PSI TIRE PRESSURE
AM2 MATS
LEGEND
FAILURE POINTS ON CLAY SUBGRADE
FAILURE POINTS ON SAND SUBGRADE
NOTE: CENTER LINE OF TRAFFIC PATH LOCATED AT JUNCTURE BETWEEN GUIDE RAIL AND AM2 MAT
TEST LANE 1-a
HARVEY MOD. AM2
TEST LANE 1
KAISER AM2
CBR
PASSES
40
30
20
15
10
9
8
7
6
5
4
3
15
20
30
40
50
70
100
150
200
300
400
500
700
1000

PLATE 14



CBR VS COVERAGES
27,000-LB SINGLE-WHEEL LOAD
400 PSI TIRE PRESSURE
KAISER AM2 MAT

PLATE 15